This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.
+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.
+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.
+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

2832

THE

EXECUTIVE DOCUMI

OF THE

HOUSE OF REPRESENTATIVES

FOR THE

SECOND SESSION OF THE FIFTY-FIRST CON(

1890-'91.

WITH INDEX.

IN THIRTY-EIGHT VOLUMES

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1891.

ПИЛЕВСЬКА
ГЕРУНДЗИМАЛОВ'ЛИЛОК
ПВКУВА

INDEX TO HOUSE EXECUTIVE DOCUMENTS.

CONTENTS OF VOLUMES.

Vol. 1..FOREIGN RELATIONS: No. 1, pt. 1.
Vol. 2..WAR: No. 1, pt. 2, v. 1.
Vol. 3.. ENGINEERS: No. 1, pt. 2, v. 2, pt. 1.
Vol. 4.. ENGINEERS: No. 1, pt. 2, v. 2, pt. 3.
Vol. 5.. ENGINEERS: No. 1, pt. 2, v. 2, pt. 3.
Vol. 6.. ENGINEERS: No. 1, pt. 2, v. 2, pt. 4.
Vol. 7.. ORDNANCE: No. 1, pt. 2, v. 3.
Vol. 8.. SIGNAL OFFICER: No. 1, pt. 2. v. 4.
Vol. 9..NAVY: No. 1, pt. 3.
Vol. 10..POSTMASTER-GENERAL: No. 1, pt. 4.
Vol. 11..INTERIOR: No. 1, pt. 5, v. 1.
Vol. 12.. No. 1, pt. 5, v. 2.
Vol. 13.. No. 1, pt. 5, v. 3.
Vol. 14.. No. 1, pt. 5, v. 4, pt. 1.
Vol. 15.. No. 1, pt. 5, v. 4, pt. 2.
Vol. 16.. No. 1, pt. 5, v. 5.
Vol. 17..AGRICULTURE: No. 1, pt. 6.
Vol. 18..DISTRICT OF COLUMBIA: No. 1, pt. 7.
Vol. 19..No. 2, Finance Report.
Vol. 20..No. 3, pts. 1 and 2.
Vol. 21..No. 1, part 8, and Nos. 4 and 7.
Vol. 22..Nos. 5 and 167.
Vol. 23..No. 6, pt. 1.
Vol. 24..No. 6, pt. 2.
Vol. 25..Nos. 8 to 47 inclusive, except No. 45.
Vol. 26..No. 45, pt. 1.
Vol. 27..No. 45, pt. 2.
Vol. 28..Nos. 48 to 128 inclusive, except Nos. 70, 80, 90, and 106, pt. 3.
Vol. 29..No. 70.
Vol. 30..No. 80.
Vol. 31..No. 90.
Vol. 32..106, pt. 3.
Vol. 33..Nos. 129 to 209 inclusive, except Nos. 165 and 167.
Vol. 34..No. 165.
Vol. 36..Nos. 210 to 295 inclusive, except Nos. 265 and 287.
Vol. 37..No. 265.
Vol. 38..No. 287.

INDEX TO DOCUMENTS

Subject.	No.	Vol.
A.		
Absecon, New Jersey. Letter recommending additional accommodations to keepers of	53	28
Agriculture, Secretary of,		
Communications from:		
Agricultural Department, expenditures in the	35	25
Annual Report of	1	17
Silk, reports relating to, for 1890	203	33
Alabama River, Alabama, report on examination of	140	33
Alaska, transportation of witnesses in	194	33
Allouez Bay and Nemadji River, Wisconsin, report on examination of	40	25
Alsea Bay and River, Oregon, report on examination of	85	28
Altamaha River, Georgia, report on examination of	283	36
Alviso Harbor and Creek, California, report of examination of	16	25
American Channel, Detroit River, report on examination of	43	25
Apache Indians, appropriation for	41	25
Appropriations:		
Estimates of the Secretary of the Treasury for	5	22
Estimates of Secretary of Treasury of deficiencies	167	22
Estimates of deficiency for payment of Army and Navy pensions	57	28
Estimates of deficiency for public printing	33	25
Arizona, letter and accompanying draft of bill for land for Indian school purposes in	216	36
Army:		
Brevet rank, letter recommending change of existing laws relative to	206	33
Quartermaster's Department, deficiencies in the	224	36
Retired officers in the civil service, report relating to	282	36
Subsistence, deficiencies for	230	36
Assateague, Virginia, letters recommending additional accommodations for keepers of	53	28

73936

Subject.

Atlanta, Ga., letter relative to heating apparatus, etc., for public b
ing at .....
Attorney-General, communications from:
Annual report of .....
Judgments, supplemental report of, rendered against the U
States.
Auburn, N. Y., appropriation for public building at .....

B.

Barnegat, New Jersey, Letter recommending additional accommod
to keepers of.....
Barnegat and Great Egg Harbor Bays, New Jersey, report on exa
tion of sound between .....
Barrundia, Gen. J. Martin, letter of the President relating t
killing of.....
Bay Ridge Channel, New York Harbor, report on examination
Bayou Black, Louisiana, report of examination of .....
Bayou Castor, Louisiana, report on examination of .....
Bayou Cocodrie, Louisiana, report on survey of .....
Bayou Des Glaises, Louisiana, report on examination of.....
Bayou Teche, Louisiana, report on examination of.....
Bayous Tigre and Chevreuil, Louisiana, report on examination of
Bayou Terre Bonne, Louisiana, report on examination of.....
Bayou Vermillion, Louisiana, report on examination of .....
Benicia Arsenal, Benicia, Cal., estimate of appropriation for ....
Berwick's Bay, Louisiana, report on examination of.....
Bethlehem Iron Company, report on ores used by the, in the man
ture of steel.....
Big Barren River, Kentucky, report on examination of.....
Binghamton, N. Y., appropriation for public building at .....
Black River, South Carolina, report on survey of.....
Blue Hill, Me., report on examination of harbor at.....
Boat or Number Four Channel, Florida, report of examination of
Boquet River, New York, report on examination of.....
Bounty on sugar, estimates of appropriation relating to.....
Brooks, S. H., relative to release of.....
Buffalo, N. Y., communication relative to site for public building
Bureau of Engraving and Printing:
Addition to the site of the building for the .....
Disbursing clerk for the.....
Burial of indigent soldiers, appropriation for.....
Buttermilk and Gowanus Bay Channels, New York Harbor, repo
examination of.....

C.

California, mining débris of .....
Clallam County, Wash., in relation to donation of proceeds of ce
lands to .....
Cane River, Louisiana, report on examination of.....
Cape May City, N. J., report on examination for breakwater at..
Cape May to Great Bay, N. J., report on examination of thoroug
from.....
Carlisle, Pa., additional estimate for Indian school at.....
Champlin's Creek, New York, report on examination of.....
Chattahoochee River, Georgia and Alabama, report on examinati
Cheyenne River Agency, S. Dak., estimate for boarding school bui
at .....
Chickahominy River, Virginia, report on examination of.....
Chickamauga and Chattanooga National Park Commission, repo
the, relative to appropriations.....
Chief of Engineers:
Annual report of .....
Annual report of .....
Annual report of .....
Annual report of .....

Subject.	No.	Vol.
Chief of Ordnance, annual report of	1	7
Chief of Bureau of Statistics, report on foreign commerce and navigation, etc	6	23
Cholera, report on, in Europe	121	28
Civilian engineers, letter of Secretary of War, relating to employed	143	33
Civil Service Commission, Annual Report of the ..... Part 8	1	21
Claims:		
Appropriation to pay the, of certain merchants of Austria-Hungary, for goods sent to the New Orleans Exposition	189	33
Deficiencies for defense of, against the United States	227	36
List of, allowed by accounting officers of the Treasury	171	33
List of, allowed since January 15, 1890	248	36
List of, allowed and paid from the indefinite appropriations of the act of April 4, 1890	249	36
Coast and Geodetic Survey:		
Annual report for 1890	80	30
Expenditures of the, for 1890	278	36
Collecting revenue from customs, letter recommending permanent appropriation for the	82	28
Colorado River, Arizona, report on survey of	18	25
Colorado River, Texas, report of examination of	138	33
Commerce and navigation, report of Chief of Bureau of Statistics on foreign	6	24
Commercial relations, 1888-'89	70	29
Commissioner of Education, annual report of	1	14, 15
Commissioner of Internal Revenue, annual report of	4	21
Commissioner of Labor:		
Annual report of	1	16
Sixth Annual Report	265	37
Commissioner of Patents, annual report of	1	13
Comptroller of Currency, annual report of	3	20
Connecticut River, report on examination of, from Long Island Sound to Hartford, etc	86	28
Consular officers, special reports of, on irrigation, canals, and ports, etc	45	26, 27
Consulate-general at London, appropriation for archives of the	137	33
Contracts, report of, entered into by the War Department	91	28
Corsica Shoal, Michigan, report on examination of	225	36
Coulson, Sewell, claim of	214	36
Court of Claims, judgments rendered by the	234	36
Courts of the United States, expenses of deficiencies for	229 259	36 36
New Mexico, additional associate justice of	76	28
Creek Indians, fulfilling treaties with	238	36
Current River, Missouri, report on examination of	157	33
Customs duties, refunds of	44	25
Customs revenue, expenses of collecting	247	36
Customs service, official emoluments of officers in the	285	36
Payments to informers and seizing officers	12	25
Tariffs, international bureau for the publication of	242	36
D.		
Deep, Skamokowa and Crooked Rivers, Washington, report on examination of	24	25
Department of Agriculture, expenditures in the	35	25
Devils Lake, N. Dak., report on examination of	293	36
Director of the Geological Survey, annual report of	1	14, 15
District of Columbia:		
Annual report of the Commissioners of the	1	18
Deficiency in appropriations for	244	36
Deficiencies for support of public schools in the	257	36
Double Bayou, Texas, report on examination of	117	33
Drum Inlet, North Carolina, report on survey of	164	33
D'Wamish and Black Rivers, Washington, report on examination of	27	25

Subject.

E.

Electric lights, letter from Secretary of the Treasury for, in public buildings
Eleventh Census, letter of the Superintendent of the, giving c returns of the population of the United States on the 1st June, 1890
Elk River, West Virginia, report on examination of
Ellis Island, appropriation for projected buildings on
Engineers, annual report of, in four parts, (vol. 2, part 1)
(vol. 2, part 2)
(vol. 2, part 3)
(vol. 2, part 4)

F.

Foreign commerce and navigation, annual report of the Chief Bureau of Statistics on the, and immigration and tonnage United States
Foreign relations, annual report of the President
Fort Canby to Ilwaco, letter of Secretary of War recommendi sideration of bill for construction of road from
Fox River, Wisconsin, letter of Secretary of War submittin of rules and regulations for the navigation and use of loc canals on the

G.

Government Hospital for the Insane, additional farm land for t
Government Printing Office, removal and storage of certain n of the
Great Lakes, report of examination for ship channel between t
Gun factories and steel forgings, report relating to, for high-pow
Gunter's Creek, Alabama, report of examination of

H.

Hamilton, Ill., report on examination of slough at
Hays, Thomas G., claim of
Hudson, Wis., report on examination of harbor at

I.

Immigrant fund, report relating to
Import duties letter requesting appropriation to pay certain, use establishment of light-houses
Indian Department, tabular statements of disbursements for 189
Indian depredation claims, list of
Indian River, Florida, report on survey of
Indian schools, amended estimates of appropriations for certain
Indian school land, letter submitting draft of bill for, in Arizon
Indian school superintendent, estimate for traveling expenses of
Indian service, supplemental estimates for the
Indians, additional subsistence for
Indigent soldiers, appropriation for burial of
Inner Bay, New York, report on examination of, near Saranac
Inspector-General, letter relative to clerks and messengers for tl of the
Interior Department:
Expenditure of contingent fund
Report of employés below a fair standard of efficiency
Public documents, report relating to the receipt, distributi sale of

Subject.	No.	Vol.
Internal-revenue stamps, appropriation for purchase of pa		
International American Conference, printing and distribut of the	166	33
International storm signals, report of a copy of draft of a l ing to		
Iron and steel, tests of, for 1890	9	25
Irrigation, etc.:		
Special reports of consular officers on, and canals, port	103	28
Report on, and water storage in the arid regions	146	28
Johnson, Capt. Henry, to place on retired list	1	3
Judgments:	1	4
Report of, against the United States	1	5
Supplemental report of, rendered against the United S	1	6
Juneau City, Alaska, public building at		
K.		
Kickapoo Indians, estimate of appropriation for fulfilling tr	6	23, 24
Lake Pontchartrain, Louisiana, report of examination of s		
Lay testimony in pension cases, report relating to	1	1
Letters, in relation to the execution of, rogatory in foreign	13	25
Lewes, Del., relating to occupancy of a portion of the iron		
Lighted gas buoys, letter recommending appropriation for		
Lights:		
Estimates for the establishment of, at Devil's Island, W	152	33
Establishment of, at Two Harbors, Minn.		
Linchester River, Maryland, report on examination of		
Little Egg Harbor Bay and Inlet, New Jersey, report on exa	126	28
Little Pigeon River, Tennessee, report on examination of		
Louisville, Ky., relief of board of commissioners of the sinki	236	36
Lower Brulé Indian Agency, letter requesting removal of, a of new buildings for	207	33
Lower Columbia River, Oregon, report on examination of	209	33
Lubec Channel, Maine, report on examination of	132	33
Lynn Haven Bay, Virginia, report on examination for wa tween Eastern Branch of Elizabeth River and		
M.		
Machine guns, appropriation for, of small-arms caliber	72	28
Magazine Gun Board, estimates of incidental expenses of tl	261	36
Mail service, report in relation to alleged irregular, in rura	268	36
Marine-Hospital Bureau, letter recommending rent of labor also, permanent bacteriologist for the	232	36
Merchant marine, letter submitting draft of a bill to establi board for the advancement of the interests of the	99	28
Military Academy, appropriation for repair of cadet sinks,	8	25
Military establishment, letter of Secretary of War relating gent expenses of the	277	36
Mineral resources, estimate for preparation of the report of	168	33
Mississippi River:	222	36
At Clinton, report on survey of	216	36
At Warsaw, Ill., report on examination of	219	36
Mokelumne River, California, report on survey of	131	33
Monks, John, & Son, claim of	139	33
	127	28
	22	25
N.		
Nandua Creek, Virginia, report on examination of	199	33
Nanticoke River, Maryland, report on examination of	130	33
Narragansett Bay Channel, Rhode Island, report on exami	58	28
National Armory, Springfield, Mass., report of expenditures		
Naval Observatory, appropriations for the new	128	28
Naval officers, petitions of, for equal pay and rank		

Subject.

Navy Department:
Additional force for the Secretary's office.....
Contingent expenses of.....
Report of employés below a fair standard of efficiency in tl
Report showing the name of employés in the.....
New Mexico, additional associate justice of.....
Newport Creek, Maryland, report on survey of.....
Newport Harbor, Rhode Island, report on examination of.....
New York:
Letter from assistant treasurer at, in relation to clerical f
the office of.....
Recruiting office, letter of Secretary of War recommend
additional clerk for.....
Nooksack, Skagit, and Snohomish Rivers, Washington, report
amination of.....
North River, Massachusetts, report on examination of shoals at
of the.....
North River, Salem, Mass., report on examination of.....
Northwest Seal Rock light station, California, purchase of fog
for.....
Nottoway River, Virginia, report on examination of.....

O.

Ohio River, report on survey of, between mouth of Green Ri
Evansville, Ind.....
Ordnance, annual report of the Chief of.....
Ordnance and ordnance stores, appropriation for, for the Dis
Columbia.....
Owensborough Harbor, Kentucky, report of examination of...

P.

Pacific railroad claims, statement of.....
Pamlico and Bay Rivers, North Carolina, report on examination
way between.....
Patapsco River, Maryland, report on examination of.....
Pease River, Florida, report on examination of.....
Pensauken Creek, New Jersey, report on examination of.....
Pension agencies, deficiencies for clerk hire, etc.....
Pensions:
Estimate of deficiency for payment of Army and Navy.....
Lay testimony, report relating to.....
Pepperell Cove, Maine, report on examination of.....
Philadelphia, Pa., site and public building for the mint at....
Phœnix, Ariz., estimate for Indian school at.....
Piscataway Creek, Maryland, report on examination of.....
Piscataway Creek, Virginia, report on examination of.....
Population of the United States, report of Superintendent of tl
sus giving complete returns of the.....
Portage Lake, Michigan, report on examinrtion of harbor lines
Port Angeles, Wash., estimate of deficiency for the survey a
praisement of land for town site at.....
Port Oxford Harbor, Oregon, report in relation to.....
Port Royal, S. C., estimate of additional appropriation for co
tion of dry dock at.....
Port Townsend, Puget Sound, and Oak Bay, Washington, repor
amination for ship channel between.....
Post-Office Department, annual report of transactions of busir
the, for 1890.....
Postmaster-General,
Communications from:
Annual report of.....
Mail service in rural districts, report in relation to alleged
lar.....

No.	Vol.	Subject.
		Postmaster-General—Continued.
		Communications from:
42	33	Post-Office Department, annual report of transactions of busi for the, 1890
29	33	Potomac Creek, Virginia, report of examination of
81	28	President of the United States,
43	36	*Communications from:*
76	28	Annual message
69	33	Barrundia, Gen. J. Martin, letter relating to the killing of
80	33	Gun factories and steel forgings, report relating to, for high-p guns
08	33	Letters, in relation to the execution of rogatory, in foreign coun
49	33	Seal fisheries of the Behring Sea, correspondence relating to
		World's Columbian Commission, report of the
38	25	Princess Bay, Staten Island, New York, report on examination of
		Public buildings, letter requesting appropriation for electric ligl
20	25	certain specified
28	25	Atlanta, Ga., relative to heating apparatus, etc., for
		Augusta, Ga., appropriation for heating and ventilating appa for the
51	33	Binghamton, N. Y., appropriation for, at
87	28	Buffalo, N. Y., relative to further legislation in regard to
		Cheyenne River Agency, S. Dak., estimates for
		Leavenworth, Kans., appropriation for repairs to the
95	33	Philadelphia, Pa. Letter requesting passage of bill for
1	7	Rochester, N. Y., appropriation for, at
		San Francisco, Cal., appropriation for extension of post-office l ing at
23	28	Public documents, report relating to the receipt, distribution, an
93	33	of, in the Interior Department
		Public lands, suspended entries, abstract of
		Public money, report on banks in which deposits of, are made
		Public papers, useless files of
54	36	Public printing, estimates of deficiency for
52	33	Pungo River to Sladesville, N. C., report on examination of wate from
02	28	Puyallup River, Washington, report on examination of
11	36	
31	25	**R.**
56	36	
57	28	Receipts and expenditures, annual report of the Treasurer on
6	36	Redwood Creek, California, report on examination of
52	28	Red River of the North, report on examination of
5	36	Retired army officers in the civil service, report relating to
8	36	Rochester, N. Y., appropriation for public building at
9	28	Rouge River, Michigan, report on examination of
9	28	Russell's Fork, Big Sandy River, Kentucky, report on examinati
		S.
9	25	
0	33	Sacramento and Feather Rivers, California, report on future imp ment of
1	33	St. Augustine Harbor, Florida, report on examination of
6	28	St. John's River, Florida, report on examination of
0	33	St. Joseph, Mo., appropriation for public building at
		St. Leonard's Creek, Maryland, report on examination of
2	28	St. Mary's Fall's Canal, Michigan, report on commerce passing
6	28, 32	San Rafael River, California, report on examination of
		San Simeon Bay, California, report on examination of
		Santa Cruz, Cal., report on examination of a harbor of refuge at
		Saugatuck River, Connecticut, report on examination of
1	10	Savannah River, Georgia, report on survey of
		Seal fisheries of Behring Sea, official correspondence relating to
6	33	Sebewaing River, Wisconsin, report of examination of

Subject.

Secretary of Agriculture:
Communications from, annual report of.....
Department of Agriculture, expenditures in the .....
Silk, reports relating to, for 1890.....
Secretary of the Interior,
Communications from:
Annual report of (in five volumes):
The Secretary (Vol. 1).....
The Secretary (Vol. 2).....
Commissioner of Education (Vol. 4).....
Commissioner of Labor (Vol. 5).....
Commissioner of Patents (Vol. 3).....
Eleventh Census, returns of the .....
Indian Department, tabular statements of disbursement
Indian depredation claims, schedule of.....
Interior Department:
Expenditure of contingent fund .....
Lay testimony in pension cases, report to the resoluti
House in relation to.....
Public documents, report regarding the receipt, distrib
sale of .....
Public lands, abstract of suspended entries .....
Population of the United States, returns of the.....
Sisseton and Wahpetons, relating to distressed condition
Secretary of the Navy,
Communications from:
Annual report.....
Navy Department:
Report of employés below a fair standard of efficienc
Contingent expenses of.....
Report showing the names of employés in the.....
Secretary of State,
Communications from:
Annual report on foreign relations.....
Cholera, report on, in Europe .....
Commercial relations, 1888, 1889.....
Consular officers, special reports on irrigation canals, po
Secretary of the Treasury,
Communications from:
Alaska, transportation of witnesses in.....
Annual report on the state of finances for 1890 .....
Appropriations, estimates of, for the service of the ye
June 30, 1892 .....
Appropriations, estimates of deficiencies.....
Appropriations, estimates of deficiency for Army and N
sions .....
Arizona, draft of bill setting apart certain lands for Indi
purposes in .....
Army, Quartermaster's Department, deficiencies in the..
Army subsistence, deficiencies for .....
Assistant treasurer at New York, increase clerical forc
office of.....
Benicia Arsenal, Benicia, Cal., estimate of appropriation
Bounty on sugar, estimates of appropriation relating to .
Brooks, S. H., relation to release of .....
Bureau of Engraving and Printing, disbursing clerk for t
Bureau of Engraving and Printing, addition to the si
building for the .....
Clallam County, Wash., relating to donation of proceeds
lands to.....
Carlisle, Pa., additional estimate for Indian school at ...
Cheyenne River Agency, S. Dak., boarding-school build
Claims, appropriation to pay the, of certain merchants o
Hungary.....
Claims, deficiencies for defending suits in, against the Uni

Subject.	No.	Vol.
Secretary of the Treasury—Continued.		
Communications from:		
Claims, list of, allowed by accounting officers of the Treasury	171	33
Claims, list of, allowed since January 15, 1890	248	36
Claims, list of, allowed and paid from the indefinite appropriations of the act of April 4, 1890	249	36
Coast and Geodetic Survey, expenditures of the, for 1890	278	36
Collecting revenue from customs, recommending permanent appropriation for	82	28
Consulate-general at London, appropriation for the archives of the	137	33
Coulson, Sewell, claim of	214	36
Court of Claims, judgments rendered by the	234	36
Courts of the United States:		
Expenses of	229	36
Deficiencies for the	259	36
New Mexico, additional associate justice of	76	28
Customs duties, refunds of	44	25
Customs revenue, expenses of collecting	247	36
Customs service, official emoluments of officers in the	285	36
Payments to informers and seizing officers	12	25
Customs tariffs, international bureau for publication of	242	36
District of Columbia, deficiencies in appropriation for the	244	36
Deficiencies for support of public schools in the	257	36
Electric lights, appropriation for, in certain public buildings	166	33
Ellis Island, appropriation for projected buildings on	146	36
Foreign commerce and navigation, annual report and statements of the Chief of the Bureau of Statistics on, etc	6	23 24
Government Hospital for the Insane, additional farm land for the	126	28
Government Printing Office, removal and storage of certain material of the	236	36
Hays, Thomas G., claim of	261	36
Immigrant fund, relating to	232	36
Import duties, appropriation to enable Light-House Board to pay, used in the establishment of light-houses, etc	99	28
Indian schools, amended estimates of appropriations for certain	222	36
Indian school superintendent, estimate of deficiency in appropriation for traveling expenses of, for 1890	219	36
Indian service, supplemental estimates for the	131	33
Indians, additional subsistence for	139	33
Apaches, appropriation for	41	25
Creeks, fulfilling treaties with	238	36
Kickapoos, estimate of appropriation for fulfilling treaties with	221	36
Lower Brulé, removal of agency of, and erection of new buildings for	105	28
Sioux, appropriation to fulfill treaty with	37	25
additional provision for the	36	25
support of different tribes of, subsistence and civilization	52	28
Indigent soldiers, appropriation for burial of	127	28
Interior Department, report of employés in the, below a fair standard of efficiency	58	28
Internal-revenue stamps, appropriation for purchase of paper for	270	36
International American Conference, printing and distributing reports of the	250	36
Lighted gas-buoys, letter recommending an appropriation for the purchase of	10	25
Light stations:		
Absecon, N. J., recommending additional accommodations for keepers of	53	28
Assateague, Virginia, recommending additional accommodations for keepers of	53	28
Barnegat, N. J., recommending additional accommodations for keepers of	53	28
Lights:		
Northwest Seal Rock light station, California, purchase of fog-signal for	151	33

Subject.

Secretary of the Treasury—Continued.
Communications from:
Lights, establishment of:
Two Harbors, Minn .....
Louisville, Ky., relating to the relief of the board of commis
of the sinking fund of .....
Machine guns of small arms caliber, appropriation for.....
Magazine-gun Board, estimates for incidental expenses of th
Marine-Hospital Bureau, laboratory and permanent bacteri
for the .....
Merchant Marine, submitting draft of bill to establish a
board for the advancement of the interests of the .....
Mineral resources, estimate for preparation of the report of.
Monks, John, & Son, claim of.....
Naval Observatory, appropriation for equipping new.....
Navy, the Secretary of, additional force for the office of the.
New York, increase force of the assistant treasurer at.....
Pacific Railroad claims, relating to .....
Pension agencies, deficiencies for clerk hire, etc.....
Pensions, deficiency for Army and Navy.....
Port Angeles, Wash., estimate of deficiency for the surve
appraisement of land for the town-site at.....
Port Royal, S. C., estimate of appropriation to complete
drydock at .....
Public buildings:
Letter requesting appropriation for electric lights in c
specified .....
Atlanta, Ga., estimate of appropriation for heating app
etc., for.....
Auburn, N. Y., requesting appropriation for, at .....
Augusta, Ga., appropriation for heating and ventilatin
ratus for.....
Binghamton, N. Y., requesting appropriation for, at ...
Buffalo, N. Y., relative to site for.....
Cheyenne River Agency, S. Dak., estimate for construc
Juneau City, Alaska, appropriation for, at.....
Leavenworth, Kans., appropriation for repairs of.....
Philadelphia, Pa., communication requesting passage
for site and, at .....
Phœnix, Ariz., estimate for Indian school at.....
Rochester, N. Y., appropriation for, at.....
St. Joseph, Mo., appropriation for, at.....
San Francisco, Cal., appropriation for extension of post
building at.....
Sitka, Alaska, requesting appropriations for, at.....
Public money, report on banks in which deposits of, are ma
Public papers, useless files of .....
Public printing, estimate of deficiency for.....
Receipts and expenditures, annual report on.....
Shipping Commissioners, expenses of the officers of the.....
expenses of the office of the.....
Sixth Auditor's Office, money-order division of the .....
Smithsonian Institution, relating to the Regents of the.....
Smuggling, etc., steamer for the prevention of .....
Thomas Ewing (revenue steamer), appropriation to rebuild t
Tobacco, amendments to existing statutes relating to the ta
Treasurer of the United States, accounts of .....
Treasury Department, contingent expenses of.....
increasing force in the assistant trea
office of the.....
Umatilla commission, claims of the .....

Subject.	No.	Vol.
Secretary of the Treasury—Continued.		
Communications from:		
Utah:		
United States penitentiary in, relative to shops at the	201	33
Appropriation for expenses of courts of	269	36
Penitentiary, appropriation for electric lights and furniture for the	258	36
Wallace, John W., salary due	75	28
World's Columbian Exposition, estimate of appropriation for the	176	33
appropriation for Government's exhibit at	177	33
Secretary of War, communications from:		
Annual report	1	2
Report of Chief of Engineers	1	3
Report of Chief of Engineers	1	4
Report of Chief of Engineers	1	5
Report of Chief of Engineers	1	6
Report of Chief of Ordnance	1	7
Report of Chief Signal Officer	1	8
Army, relative to brevet rank of officers	206	33
Retired, officers in the civil service, report of the	282	36
Bethlehem Iron Company, report on ores used by the, for the manufacture of steel	294	36
California, Mining débris of	267	36
Chickamauga and Chattanooga National Military Park Commission, report of the, relative to appropriations	98	28
Civilian engineers, letter, relative to	143	33
Fort Canby to Ilwaco, letter requesting early consideration of bill for construction of wagon road from	13	25
International storm signals, report submitting draft of a bill pertaining to	288	36
Iron and steel, tests of, for 1890	165	34
Irrigation, report on, and storage of water in the arid regions	287	38
Johnson, Capt. Henry, placed on retired list	183	33
Lewes, Del., in relation to the occupancy of a portion of the iron pier at	239	36
Military Academy, recommending an additional appropriation for repair of cadet sinks, etc	223	36
Military establishment, expenditures of, contingent expenses of the, for 1890	148	33
National Armory, Springfield, Mass., report of expenditures at the	77	28
New York recruiting office, letter recommending additional clerk at	149	33
Ordnance and ordnance stores, letter relating to omission of item for, for the District of Columbia	123	28
Rivers and harbors:		
Alabama River, Alabama, report on examination of	140	33
Allouez Bay and Nemadji River, Wisconsin, report on examination of	40	25
Alsea Bay and River, Oregon, report on examination of	85	28
Altamaha River, Georgia, report on examination of	283	36
Alviso Harbor and Creek, California, report of examination of	16	25
American Channel, Detroit River, report on examination of	43	25
Barnegat and Great Egg Harbor Bays, New Jersey, report on examination of sound between	42	25
Bay Ridge Channel, New York Harbor, report on examination of	60	28
Bayou Black, Louisiana, report of examination of	113 125	28 28
Bayou Castor, Louisiana, report on examination of	185	33
Bayou Cocodrie, Louisiana, report on survey of	114	28
Bayou Des Glaises, Louisiana, report on examination of	119	28
Bayou Teche, Louisiana, report on examination of	280	36
Bayou Terre Bonne, Louisiana, report on examination of	110	28
Bayou Tigre and Chevreuil, Louisiana, report on examination of	182	33
Bayou Vermillion, Louisiana, report on examination of	273	36
Berwick's Bay, Louisiana, report on examination of	198	33
Big Barren River, Kentucky, report on examination of	15	25

Subject.

Secretary of War—Continued.
Communications from:
Rivers and Harbors—Continued.
Black River, South Carolina, report on survey of.....
Blue Hill Harbor, Maine, report and survey of.....
Boat or Number Four Channel, Florida, report of examination of.....
Boquet River, New York, report on examination of.....
Buttermilk and Gowanus Bay Channels, New York Harbor, report on examination of.....
Cane River, Louisiana, report on examination of.....
Cape May City, N. J., report on examination for breakwater at
Cape May to Great Bay, New Jersey, report on examination for a thoroughfare from.....
Champlin's Creek, New York, report on examination of.....
Chattahoochee River, Georgia and Alabama, report on examination of.....
Chickahominy River, Virginia, report on examination of.....
Colorado River, Arizona, report on survey of.....
Colorado River, Texas, report on examination of.....
Connecticut River, report on examination of, from Long Island Sound to Hartford, etc.....
Corsica Shoal, Michigan, report on examination of.....
Current River, Missouri, report on examination of.....
Deep, Skamokawa and Crooked Rivers, Washington, report on survey of.....
Devil's Lake, North Dakota, report on examination of.....
Double Bayou, Texas, report on examination of.....
Drum Inlet, North Carolina, report on survey of.....
D'Wamish and Black Rivers, Washington, report on examination of.....
Elk River, West Virginia, report on examination of.....
Fox River, Wisconsin, letter submitting a draft of rules and regulations for the navigation and use of locks and canals of the.....
Gunter's Creek, Alabama, report on examination of.....
Hamilton, Ill., report on examination of the slough at.....
Hudson, Wis., report on examination of harbor at.....
Indian River, Florida, report on survey of.....
Inner Bay, New York, report on examination of, near mouth of Saranac River.....
Lake Pontchartrain, Louisiana, report on examination of shoals on.....
Linchester River, Maryland, report on examination of.....
Little Egg Harbor, Bay, and Inlet, New Jersey, report on examination of.....
Little Pigeon River, Tennessee, report on examination of.....
Lower Columbia River, Oregon, report on examination of.....
Lubec Channel, Maine, report on examination of.....
Lynn Haven Bay, Virginia, report on examination for a water way between eastern branch of Elizabeth River and.....
Mississippi River at Clinton, Iowa, report on survey of.....
Mississippi River at Warsaw, Ill., report on examination of...
Mokelumne River, California, report on survey of.....
Nandua Creek, Virginia, report on examination of.....
Nanticoke River, Maryland, report on examination of.....
Narragansett Bay Channel, Rhode Island, report on examination of.....
Newport Creek, Maryland, report on survey of.....
Newport Harbor, Rhode Island, report on examination of.....
Nooksack, Skagit, and Snohomish Rivers, Washington, report on examination of.....
North River, Massachusetts, report on examination of shoals at the mouth of the.....
North River, Salem, Mass., report on survey of.....

Vol.	Subject.
	Secretary of War—Continued.
	Communications from:
	Rivers and harbors—Continued.
36	Nottoway River, Virginia, report on examination of
25	Ohio River, report on survey of, between mouth of Green Riv and Evansville, Ind
33	Owensborough Harbor, Kentucky, report of, examination of
25	Pamlico and Bay Rivers, North Carolina, report on examinati of water-way between
25	Patapsco River, Maryland, report on examination of
33	Pease River, Florida, report on examination of
25	Pensauken Creek, New Jersey, report on examination of
	Pepperell Cove, Maine, report on examination of
28	Piscataway Creek, Maryland, report on examination of
28	Piscataway Creek, Virginia, report on examination of
	Portage Lake, Michigan, report on examination of harbor lin at
33	
36	Port Oxford Harbor, Oregon, report in relation to
25	Port Townsend Bay, Puget Sound, and Oak Bay, Washingto
33	report of examination of ship channel between
	Potomac Creek, Virginia, report on examination of
28	Princess Bay, Staten Island, New York, report on examin
36	tion of
33	Pungo River to Sladesville, N. C., report on examination of tl water way from
25	Puyallup River, Washington, report on examination of
36	Red River of the North, report on the examination of
28	Redwood Creek, California, report on examination of
33	Rouge River, Michigan, report on examination of
	Russell's Fork, Big Sandy River, Kentucky, report on examin
25	tion of
28	Sacramento and Feather Rivers, California, report on future ir provement of
	St. Augustine Harbor, Florida, report on examination of
33	St. John's River, Florida, report on examination of
33	St. Leonard's Creek, Maryland, report on examination of
28	San Rafael River, California, report on examination of
36	San Simeon Bay, California, report on examination of
33	Santa Cruz, California, report on examination for a harbor refuge at
25	Saugatuck River, Connecticut, report on examination of
	Savannah River, Georgia, report on survey of
28	Sebewaing River, Michigan, report on examination of
33	Shark River, New Jersey, report on examination of
	Shaw's Cove, New London Harbor, Connecticut, report on e
25	amination of
33	Ship channel between the Great Lakes, report on examinati
28	of
33	Smithland, Ky., report on examination of harbor at
	Stony Creek River, Connecticut, report on survey of
28	Sucarnoochee River, Alabama, report on examination of
33	Sullivan Falls, Maine, report on examination of
28	Tangier Harbor, Virginia, report on examination of
33	Tionesta Creek, Pennsylvania, report on examination of
36	Tongue River, Montana, report on examination of
33	Town River, Massachusetts, report on survey of
	Trinity River, Texas, report on examination of
33	Upper Machodoc Creek, Virginia, report on examination of.
33	Wabash River, Indiana, report on examination of
33	Washington Harbor, North Carolina, report on, examination
	Watch Hill Cove, Rhode Island, report on examination of
25	Wateree River, South Carolina, report on examination of
	Western Branch of Elizabeth River, Virginia, report on surv
25	of
25	Weymouth Back River, Massachusetts, report on survey of.
	White Oak River, North Carolina, report on examination of

Subject.

Secretary of War—Continued.
Communications from:
Rivers and harbors—Continued.
Willamette River, Oregon, report on examination of
Willow Slough, Illinois, report relative to reopening of
Young's Bay Channel, Columbia River, report on examination of
St. Mary's Falls Canal, Michigan, report on commerce passing
War Department, accounts of disbursing officers of the
contingent expenses of
clerks and messengers for the Inspector-General's Office
efficiency of employés in the
list of employés of the
Report of contracts entered into by the
Report of purchases by the Quartermaster's Department of the
Washington and Great Falls Electric Railway Company, report giving reasons why the, should not be allowed to lay tracks
West Branch of the Susquehanna River, Pennsylvania, report of examination of
Shark River, New Jersey, report on examination of
Shaw's Cove, New London HarborsConnecticut, report on examination of
Ship channel between the Great Lakes, report of examination for a
Shipping commissioners:
Expenses of the officers of the
Expenses of the office of the
Silk, report relating to, for 1890
Sioux Indians:
Additional provisions for the
Support of, of different tribes, subsistence and civilization
Appropriation to fulfill treaty with
Sisseton and Wahpeton Indians, letter relating to distressed condition of.
Sitka, Alaska, appropriation for repairs of public building at
Sixth Auditor's Office, rent for money-order division of the
Smithland, Ky., report on examination of harbor at
Smithsonian Institution, relating to the Regents of the
Smuggling, etc., steamer for the prevention of, on the west coast of of Florida
Statistical Abstract
Story Creek River, Connecticut, report on survey of
Sucarnoochee River, Alabama, report on examination of
Sugar, bounty on, estimates of appropriation relating to
Sullivan Falls, Maine, report on examination of.

T.

Tangier Harbor, Virginia, report on examination of
Thomas Ewing, revenue steamer, appropriation to rebuild
Trinity River, Texas, report on examination of
Tionesta Creek, Pennsylvania, report on examination of
Tobacco, amendments to existing laws relating to tax on
Tongue River, Montana, report on examination of
Town River, Massachusetts, report on survey of
Treasurer, United States, accounts of
Treasury Department:
Contingent expenses of
Increasing force in the assistant treasurer's office

U.

Umatilla Commission, claims of the
Upper Machodoc Creek, Virginia, report on examination of
Utah:
Letter relative to workshops for penitentiary in
Appropriation for expenses of courts of
Utah penitentiary, appropriation for electric lights and furniture for the.

Subject.	No.	Vol.
W.		
Wabash River, Indiana, report on examination of	74	28
Wallace, John W., salary due	284	36
War Department:		
Accounts of disbursing officers of the	67	28
Letter of the Secretary of War relating to contingent expenses	95	28
Report of purchases by the Quartermaster's Department of the	14	25
Report of contracts entered into by the	34	25
List of employés of the	199	33
Report of employés in the, below a fair standard of efficiency	202	33
Washington and Great Falls Electric Railway Company, report of the Secretary of War setting forth reasons why the, should not be allowed to lay certain tracks	197	33
Washington Harbor, North Carolina, report on examination of	91	28
Watch Hill Cove, Rhode Island, report on examination of	89	28
Wateree River, South Carolina, report on examination of	274	36
West Branch of the Susquehanna River, Pennsylvania, report of examination of	136	33
Western Branch of Elizabeth River, Virginia, report on survey of	25	25
Weymouth Back River, Massachusetts, report on survey of	73	28
White Oak River, North Carolina, report on examination of	207	33
Willamette River, Oregon, report on examination of	71	28
Willow Slough, Illinois, relative to reopening of	263	36
World's Columbian Commission, report of the	203	33
World's Columbian Exposition:		
Estimate of appropriation for the	36	25
Appropriation for Government's exhibit at	52	28
Y.		
Young's Bay Channel, Columbia River, report on examination of	37	25
	100	28
	235	36
	237	36
	253	36
	107	28
	279	36
	226	36
	46	25
	124	28
	116	28
	186	33
	84	28
	172	33
	112	28
	275	36
	196	33
	170	33
	118	29
	155	33
	90	31
	11	25
	96	28
	210	36
	63	28
	201	33
	269	36
	258	36

51ST CONGRESS, 2d Session. } HOUSE OF REPRESENTATIVES. { Ex. Doc. 1, Part 2.

REPORT

OF THE

SECRETARY OF WAR;

BEING PART OF

THE MESSAGE AND DOCUMENTS

COMMUNICATED TO THE

TWO HOUSES OF CONGRESS

AT THE

BEGINNING OF THE SECOND SESSION OF THE FIFTY-FIRST CONGRESS.

IN FOUR VOLUMES.

VOLUME II—IN FOUR PARTS.

PART 1.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1890.

CONTENTS.

[Alphabetical index will be found at the end of each part.]

PART I.

OFFICERS OF THE CORPS OF ENGINEERS 3

SEA-COAST DEFENSES 4

THE BOARD OF ENGINEERS.

Officers constituting Board, 6; summary of reports rendered, 6; additional duties of individual members, 8.

WHARF AT FORT MONROE, VIRGINIA.

IN CHARGE OF LIEUT. COL. PETER C. HAINS, CORPS OF ENGINEERS..... 9

IRON PILE BRIDGE OVER MILL CREEK AT FORT MONROE, VIRGINIA.

IN CHARGE OF LIEUT. COL. PETER C. HAINS, CORPS OF ENGINEERS..... 9

POST OF WILLETS POINT, NEW YORK.—ENGINEER SCHOOL OF APPLICATION.—BATTALION OF ENGINEERS.—ENGINEER DEPOT.

OFFICER IN COMMAND, LIEUT. COL. W. R. KING, CORPS OF ENGINEERS—

Post of Willets Point, Engineer School of Application, 10; Battalion of Engineers, Engineer Depot, 11; Statement of funds, 12.

RIVER AND HARBOR IMPROVEMENTS.

GENERAL STATEMENT, 12; South Pass of Mississippi River, commercial statistics, 14.

ATLANTIC COAST AND GULF OF MEXICO.

IN CHARGE OF LIEUT. COL. JARED A. SMITH, CORPS OF ENGINEERS—

Lubec Channel, Me., Moose-a-bec Bar, Me., 15; Narragaugus River, Me., Breakwater from Mount Desert to Porcupine Island, Me., 16; Bagaduce River, Me., Penobscot River, Me., 17; Belfast Harbor, Me., 18; Camden Harbor, Me., Rockport Harbor, Me., 19; Rockland Harbor, Me., Kennebec River, Me., 20; Portland Harbor, Me., Channel in Back Cove, Portland, Me., 21; Breakwater at mouth of Saco River, Me., 22; Saco River, Me., Kennebunk River, Me., York Harbor, Me., 23; Portsmouth Harbor, N. H., 24; Bellamy River, N. H., Cocheco River, N. H., harbor of refuge at Little Harbor, N. H., 25; examinations and surveys, 26.

IN CHARGE OF LIEUT. COL. S. M. MANSFIELD, CORPS OF ENGINEERS—

Newburyport Harbor, Mass., Merrimac River, Mass., 27; Powow River, Mass., 28; Ipswich River, Mass., harbor of refuge, Sandy Bay, Cape Ann, Mass., 29; Gloucester Harbor, Mass., 30; Manchester Harbor, Mass., Lynn Harbor, Mass., 31; Winthrop Harbor, Mass., 32; Boston Harbor, Mass., 33; Hingham Harbor, Mass., Scituate Harbor, Mass., 34; Plymouth Harbor, Mass., 35; Wellfleet Harbor, Mass., Provincetown Harbor, Mass., 36; removal of sunken vessels or craft obstructing or endangering navigation, 37; examinations and surveys, 37.

IN CHARGE OF MAJ. WILLIAM R. LIVERMORE, CORPS OF ENGINEERS—

Harbor of refuge at Hyannis, Mass., 38; harbor of refuge at Nantucket bor at Vineyard Haven, Mass., 39; Wareham Harbor, Mass., 40; N Harbor, Mass., 41; Taunton River, Mass., 42; Warren River, R. I., River, R. I., 43; Providence River and Narragansett Bay, R. I., 44; Green Jacket Shoal, Providence River, R. I., 45; Newport Harbor, R. bor of refuge at Block Island, R. I., 47; Pawcatuck River, R. I. and harbor of refuge at Stonington, Conn., 49; removing sunken vessels structing or endangering navigation, 50; examinations and surveys, 8

IN CHARGE OF COL. D. C. HOUSTON, CORPS OF ENGINEERS—

Thames River, Conn., New London Harbor, Conn., 51; Connecticut Rive Conn., 52; Clinton Harbor, Conn., New Haven Harbor, Conn., breakw Haven, Conn., 54; Milford Harbor, Conn., 55; Housatonic River, Co port Harbor, Conn., 56; Black Rock Harbor, Conn., Norwalk Harbo harbor at Five-mile River, Conn., Stamford Harbor, Conn., 58; Port (bor, N. Y., 59; Echo Harbor, New Rochelle, N. Y., New Rochelle Ha East Chester Creek, N. Y., 60; Greenport Harbor, N. Y., Glen Cove H 61; Flushing Bay, N. Y., removing sunken vessel or craft obstructi gering navigation, 62; examinations and surveys, 62.

IN CHARGE OF LIEUT. COL. G. L. GILLESPIE, CORPS OF ENGINEERS—

Hudson River, N. Y., 63; harbor at Saugerties, N. Y., harbor at Rondo Harlem River, N. Y., 65; removing obstructions in East River and E Y., 66; Newtown Creek, N. Y., 68; Buttermilk Channel, New York Gowanus Bay, N. Y., 70; New York Harbor, 71; Raritan Bay, N. J., 7 tions and surveys, 74.

IN CHARGE OF CAPT. THOS. L. CASEY, CORPS OF ENGINEERS—

Sheepshead Bay, N. Y., 74; Canarsie Bay, N. Y., Sumpawanus Inlet, N. Y Kill, N. Y. and N. J., 76; channel between Staten Island and New Jer saic River, N. J., 78; Elizabeth River, N. J., 79; Rahway River, N. J., River, N. J., 81; South River, N. J., 82; Shrewsbury River, N. J., Key N. J., 83.

IN CHARGE OF MAJ. CHAS. W. RAYMOND, CORPS OF ENGINEERS—

Delaware River, Pa. and N. J., 84; harbor between Philadelphia, Pa., N. J., 86; Schuylkill River, Pa., 87; ice harbor at Marcus Hook, Pa., 8 at head of Delaware Bay, Del., construction of iron pier in Delawa Lewes, Del., 89; Delaware Breakwater Harbor, Del., 90; Mantua Cre removal of wrecks from Delaware Bay and River, removing sunken ve obstructing or endangering navigation, 92; examination and survey,

IN CHARGE OF WILLIAM F. SMITH, UNITED STATES AGENT, MAJOR OF U. S. ARMY, RETIRED—

Maurice River, N. J., 92; Wilmington Harbor, Del., 93; ice harbor at Del., Duck Creek, Del., 74; St. Jones River, Del., 95; Mispillion Broadkiln River, Del., 96; inland waterway from Chincoteague Bay, ware Bay, at or near Lewes, Del., 97; Broad Creek, Del., Susquehanna and below Havre de Grace, Md., 98; Fairlee Creek, Md., 99; Corsica Choptauk River, Md., 100; Cambridge Harbor, Md., removing sunk craft obstructing or endangering navigation, 101; examinations and

IN CHARGE OF COL. WM. P. CRAIGHILL, CORPS OF ENGINEERS—

Channel to Baltimore, Md., 102; James River, Va., 103.

IN CHARGE OF LIEUT. G. J. FIEBEGER, CORPS OF ENGINEERS—

Harbor of Norfolk, and its approaches, Va., 104; approach to Norfolk the United States (Norfolk) navy-yard between Lambert's Point and I Va., 105; Nansemond River, Va., Appomattox River, Va., 106; No River, Va. and N. C., 107; Currituck Sound, Coanjok Bay, and Nort N. C., removing sunken vessels or craft obstructing or endangering 108.

IN CHARGE OF LIEUT. COL. PETER C. HAINS, CORPS OF ENGINEERS—

Potomac River at Washington, D. C., 108; bridge across Eastern Branc River, D. C., 110; Shenandoah River, W. Va., 111.

IN CHARGE OF MR. S. T. ABERT, UNITED STATES AGENT—

Patuxent River, Md., from Benedict to Hill's Landing, 111; channel at Mount Vernon, Va., Breton Bay, Leonardtown, Md., 112; Nomini Creek, Va., 113; harbor at entrance of St. Jerome's Creek, Md., Rappahannock River, Va., 114; Urbana Creek, Va., 115; Totusky River, Va., Mattaponi River, Va., 116; Pamunky River, Va., 117; York River, Va., 118; Chickahominy River, Va., Staunton River, Va., 119; Dan River, Va. and N. C., 120; removing sunken vessels or craft obstructing or endangering navigation, 121; examinations and surveys, 121.

IN CHARGE OF CAPT. WILLIAM H. BIXBY, CORPS OF ENGINEERS—

Roanoke River, N. C. and Va., 121; Pamlico and Tar Rivers, N. C., 122; Contentnia Creek, N. C., 123; Trent River, N. C., Neuse River, N. C., 124; inland waterway between New Berne and Beaufort, N. C., 125; harbor at Beaufort, N. C., 126; inland waterway between Beaufort Harbor and New River, N. C., 127; New River, N. C., Black River, N. C., 128; Cape Fear River, N. C., 129 and 130; Yadkin River, N. C., 131; harbor at Georgetown, S. C., Winyaw Bay, S. C., 132; examinations and surveys, 133.

IN CHARGE OF CAPT. FREDERIC V. ABBOT, CORPS OF ENGINEERS—

Charleston Harbor, S. C., 134; Lumber River, N. C., Mingo Creek, S. C., 135; Clark Creek, S.C., Ashley River, S.C., Edisto River, S.C., 136; Salkahatchie River, S.C., 137; Little Pee Dee River, S. C., Great Pee Dee River, S. C., Santee River, S. C., 138; Wateree River, S. C., Congaree River, S. C., 139; Wappoo Cut, S. C., Waccamaw River, N. C. and S. C., 140; removing sunken vessels or craft obstructing navigation, 141; examinations and surveys, 141.

IN CHARGE OF LIEUT. O. M. CARTER, CORPS OF ENGINEERS—

Savannah River and Harbor, Ga., Savannah River, Ga., 142; Savannah River, above Augusta, Ga., Romley Marsh, Ga., 143; Altamaha River, Ga,, Oconee River, Ga., 144; Ocmulgee River, Ga., 145; Brunswick Harbor, Ga., Jekyl Creek, Ga., Cumberland Sound, Ga. and Fla., 146; examinations and surveys, 147.

IN CHARGE OF CAPT. WM. M. BLACK, CORPS OF ENGINEERS—

St. John's River, Fla., 147; Volusia Bar, Fla., St. Augustine Harbor, Fla., 149; northwest entrance, Key West Harbor, Fla., 150; Caloosahatchee River, Fla, 151; Pease River, Fla., Manatee River, Fla., 152; Tampa Bay, Fla., 153; Withlacoochee River, Fla., 154; Cedar Keys Harbor, Fla., Suwanee River, Fla., 155; removing sunken vessels or craft obstructing or endangering navigation, 156; examination and survey, 156.

IN CHARGE OF CAPT. PHILIP M. PRICE, CORPS OF ENGINEERS—

Apalachicola River, Fla., 156; Apalachicola Bay, Fla., 157; La Grange Bayou, Fla., 158; Pensacola Harbor, Fla., 159; Choctawhatchee River, Fla. and Ala., 160; Escambia and Conecuh rivers, Fla. and Ala., Flint River, Ga., 161; Coosa River, Ga. and Ala., 162; Chattahoochee River, Ga. and Ala., 164; Tallapoosa River, Ala., Cahaba River, Ala., 165; Alabama River, Ala., 166; operating and care of locks and dams on Coosa River, Ga. and Ala., 167; examination and survey, 167.

IN CHARGE OF MAJ. A. N. DAMRELL, CORPS OF ENGINEERS—

Mobile Harbor, Ala., Black Warrior River, Ala., from Tuscaloosa to Daniels Creek, 168; Warrior and Tombigbee rivers, Ala. and Miss., 169; Noxubee River, Miss., 171; Pascagoula River, Miss., Biloxi Harbor, Miss., 172; Pearl River, Miss., from Edinburg to Carthage, and from Jackson to Carthage, 173; Pearl River, Miss., below Jackson, 174; examinations and surveys, 175.

IN CHARGE OF CAPT. W. L. FISK, CORPS OF ENGINEERS—

Inspection of improvement at South Pass of the Mississippi River, 175; Tchefuncte River and Bogue Falia, La., 175; Tickfaw River and its tributaries, La., 176; Amite River, La., Bayou La Fourche, La., 177; Bayou Terrebonne, La., Bayou Plaquemine, La., 178; Bayou Courtableau, La., 179; Calcasieu River and Pass, La., Sabine River, La. and Tex., 180; Neches River, Tex., Sabine Pass, Tex., 181.

IN CHARGE OF CAPT. DAN C. KINGMAN, CORPS OF ENGINEERS—

Securing mouth of Bayou Plaquemine, La., from further caving, 182.

IN CHARGE OF MAJ. CHAS. J. ALLEN, CORPS OF ENGINEERS—

Entrance to Galveston Harbor, Tex., 182; ship channel in Galveston B Trinity River, Tex., 184; Buffalo Bayou, Tex., Aransas Pass and Ba port and Corpus Christi, Tex., harbor at Brazos Santiago, Tex., 185; and survey, 186.

WESTERN RIVERS.

IN CHARGE OF CAPT. J. H. WILLARD, CORPS OF ENGINEERS—

Red River, La. and Ark., 186; Ouachita and Black rivers, Ark. and River, Ark., above Camden, 188; Bayou D'Arbonne, La., Little Riv Bartholomew, La. and Ark., 189; Bayou Bœuf, La., Tensas River and La., 190; Big Black River, Miss., Yazoo River, Miss., 191; Tchula Tallahatchee River, Miss., 192; Steele's Bayou, Miss., Big Sunflowe Big Hatchee River, Tenn., 193; Forked Deer River, Tenn., water Mississippi River and its principal tributaries, 194; Cypress Bayou between Jefferson, Tex., and Shreveport, La., 195.

IN CHARGE OF CAPT. H. S. TABER, CORPS OF ENGINEERS—

Red River, above Fulton, Ark., 195; Little Red River, Ark., removing in Arkansas River, Ark. and Kans., 196; Arkansas River, Ark., 19 River, Ark., 198; Fourche River, Ark., White River, Ark., 199; Cach Black River, Ark. and Mo., 200; Black River, Mo., St. Francis Riv St. Francis River, Mo., Little River, Mo. and Ark., 202.

IN CHARGE OF MAJ. A. M. MILLER, CORPS OF ENGINEERS—

Removing snags and wrecks from Mississippi River, Mississippi R Ohio and Illinois rivers, 203; Gasconade River, Mo., Osage River, vey, 206.

IN CHARGE OF MAJ. E. H. RUFFNER, CORPS OF ENGINEERS—

Mississippi River between Des Moines Rapids and mouth of the Illin

IN CHARGE OF MAJ. ALEXANDER MACKENZIE, CORPS OF ENGINEERS-

Operation of snag boats and dredge boats on Upper Mississippi Rive sippi River from Minneapolis to Des Moines Rapids, Des Moines Rapid River, 208; operating and care of Des Moines Rapids Canal, Mississip dock at Des Moines Rapids Canal, harbor of refuge on Lake Pepin, Wis., 209.

IN CHARGE OF MAJ. WILLIAM A. JONES, CORPS OF ENGINEERS—

Mississippi River above Falls of St. Anthony, Minn., 210; reservoirs at Mississippi River, 211; Chippewa River, including Yellow Banks, W River, Wis. and Minn., 212; Minnesota River, Minn., 213; Red River Minn. and Dak., 214; surveys for reservoirs at the sources of the M Croix, Chippewa, and Wisconsin rivers, Yellowstone River, Mont. an ing Mississippi River at or near St. Paul, Minn., 215.

IN CHARGE OF LIEUT. COL. J. W. BARLOW, CORPS OF ENGINEERS—

Tennessee River, 216; French Broad River, Tenn., 219; Hiawassee Clinch River, Tenn., 220; Cumberland River, Tenn. and Ky., 221; S Cumberland River, Ky., 222; Caney Fork River, Tenn., examination 223.

IN CHARGE OF LIEUT. COL. WILLIAM E. MERRILL, CORPS OF ENGINE

Ohio River, 224; operating and care of Davis Island Dam, Ohio River, River, W. Va. and Pa., operating and care of locks and dams No. 8 a gahela River, purchase of lock and dam No. 7, Monongahela River, 22 River, Pa., dam at Herr's Island, Allegheny River, ice harbor at mou gum River, Ohio, 227; Muskingum River, Ohio, operating and care dams on Muskingum River, Ohio, 228.

Tex., 183;
› to Rock-
amination

Ouachita
a., Bayou
ou Macon,
ke, Miss.,
ver, Miss.,
ges on the
the lakes

structions
'etit Jean
ver, Ark.,
Ark., 201;

between
205; sur-

River, 206.

7; Missis-
ississippi
iver, dry
ockholm,

waters of
St. Croix
he North,
sippi, St.
ak., gaug-

er, Tenn.,
h Fork of
d survey,

—

ongahela
9, Monon-
Allegheny
f Muskin-
locks and

CONTENTS.

IN CHARGE OF CAPT. EDW. MAGUIRE, CORPS OF ENGINEERS—

Falls of the Ohio, Louisville, Ky., 229; Indiana Chute, Falls of t ating and care of Louisville and Portland Canal, 230; Wab Ill., 231; White River, Ind., 232.

IN CHARGE OF COL. WILLIAM P. CRAIGHILL, CORPS OF ENGI

Great Kanawha River, W. Va., 232; operating and care of lock Kanawha River, W. Va., 233; Elk River, W. Va., Gauley I New River from the mouth of Wilson, in Grayson County, Greenbrier River, W. Va., 235.

IN CHARGE OF MAJ. D. W. LOCKWOOD, CORPS OF ENGINEER

Tradewater River, Ky., 236; operating and keeping in repair th Green and Barren rivers, Ky., Kentucky River, Ky., 237; op in repair the locks and dams on Kentucky River, Ky., Licki Farmer's to West Liberty, 238; Big Sandy River, W. Va. a River, W. Va., 239; Little Kanawha River, W. Va., Buckhanno

LAKE HARBORS AND RIVERS.

IN CHARGE OF MAJ. JAMES B. QUINN, CORPS OF ENGINEERS—

Harbor at Grand Marais, Minn., harbor at Agate Bay, Minn., 241 Minn., 242; harbor at Superior Bay and St. Louis Bay, Wis., land, Wis., harbor at Ontonagon, Mich., 244; Eagle Harbo Marquette, Mich., 245; harbor of refuge at Grand Marais, and maintenance of harbor lines in Portage Lake, Mich., 24 surveys, 247.

IN CHARGE OF MAJ. CHARLES E. L. B. DAVIS, CORPS OF ENGI

Manistique Harbor, Mich., 247; Cedar River Harbor, Mich., Mich. and Wis., 248; Oconto Harbor, Wis., Pensaukee Harb Bay Harbor, Wis., harbor of refuge at entrance of Sturgeon B Ahnapee Harbor, Wis., Kewaunee Harbor, Wis., 251; Two R Manitowoc Harbor, Wis., 252; Sheboygan Harbor, Wis., Po bor, Wis., 253; harbor of refuge at Milwaukee Bay, Wis., Wis., 254; Racine Harbor, Wis., 255; Kenosha Harbor, Wis., Ill., 256; Fox and Wisconsin rivers, Wis., 257; operating an dams on Fox River, Wis., 258; examinations and surveys, 25

IN CHARGE OF CAPT. W. L. MARSHALL, CORPS OF ENGINEERS—

Chicago Harbor, Ill., 259; Calumet Harbor, Ill., 260; Illinois Ri ing and care of La Grange Lock, Calumet River, Ill. and Ind. Illinois and Mississippi Canal, 263.

IN CHARGE OF MAJ. WILLIAM LUDLOW, CORPS OF ENGINEERS

Charlevoix Harbor and entrance to Pine Lake, Mich., 264; Fran 265; harbor of refuge at Portage Lake, Mich., Manistee Harb ington Harbor, Mich., 267; Pentwater Harbor, Mich., White 268; Muskegon Harbor, Mich., 269; Grand Haven Harbor, Mi Harbor, Mich., Saugatuck Harbor, Mich., 271; South Haver Joseph Harbor, Mich., 272; St. Joseph River, Mich., Michiga 273; examination and survey, 274.

IN CHARGE OF COL. O. M. POE, CORPS OF ENGINEERS—

St. Mary's River, Mich., 275; operating and care of St. Mary's dry dock at St. Mary's Falls Canal, Mich., 276; Hay Lake River, Mich., 277; harbor at Cheboygan, Mich., harbor at 278; harbor at Au Sable, Mich., 279; Saginaw River, Mich., 2 at Sand Beach, Lake Huron, Mich., 281; mouth of Black Ri Flats Canal, Mich., 283; operating and care of St. Clair Flats Pointe Channel, Mich., 285; Clinton River, Mich., 286; Detro Rouge River, Mich., 288; examination and survey, 289.

IN CHARGE OF MAJ. L. COOPER OVERMAN, CORPS OF ENGINEERS—

Monroe Harbor, Mich., 289; Toledo Harbor, Ohio, 290; Port Clinton Sandusky City Harbor, Ohio, 291; Sandusky River, Ohio, 292; Huron Vermillion Harbor, Ohio, 293; Black River Harbor, Ohio, Cleveland 294; Fairport Harbor, Ohio, 295; Ashtabula Harbor, Ohio, removin sels or craft obstructing or endangering navigation, 296.

IN CHARGE OF MAJ. AMOS STICKNEY, CORPS OF ENGINEERS—

Erie Harbor, Pa., 297; preservation and protection of the peninsula at Erie Harbor, Pa., Dunkirk Harbor, N. Y., 298; Buffalo Harbor, N. Y Harbor and Niagara River, N. Y., 299; Wilson Harbor, N. Y., 300; (N. Y., Oak Orchard Harbor, N. Y., 301.

IN CHARGE OF MAJ. MILTON B. ADAMS, CORPS OF ENGINEERS—

Charlotte Harbor, N. Y., 302; Great Sodus Harbor, N. Y., Little Sodus 303; Oswego Harbor, N. Y., 304; Sackett's Harbor, N. Y., 305.

IN CHARGE OF MAJ. MILTON B. ADAMS, CORPS OF ENGINEERS—

Ogdensburgh Harbor, N. Y., 305; Grass River (at Massena), N. Y., Rouse's Point, Lake Champlain, N. Y., 306; channel between Nor Hero Islands, Lake Champlain, Vt., breakwater at Gordon's Landing plain, Vt., Plattsburgh Harbor, N. Y., 307; Burlington Harbor, Vt. Vt., 308; Ticonderoga River, N. Y., Narrows at Lake Champla Vt., 309.

PACIFIC COAST.

IN CHARGE OF COL. G. H. MENDELL, CORPS OF ENGINEERS—

Napa River, Cal., 309; Oakland Harbor, Cal., 310; survey of San Fran San Pablo and Suisun bays, Straits of Carquinez, and mouths of San Sacramento rivers, 311.

IN CHARGE OF LIEUT. COL. W. H. H. BENYAURD, CORPS OF ENGIN

Redwood Harbor, Cal., San Luis Obispo Harbor, Cal., 311; Wilmington 312; San Diego Harbor, Cal., 313.

IN CHARGE OF MAJ. W. H. HEUER, CORPS OF ENGINEERS—

San Joaquin River, Stockton and Mormon sloughs, Cal., 313; Mokel Cal., Sacramento and Feather rivers, Cal., 314; Petaluma Creek, Cal boldt Harbor and Bay, Cal., 316.

IN CHARGE OF CAPT. THOMAS W. SYMONS, CORPS OF ENGINEERS—

Coquille River, Oregon, 317; entrance to Coos Bay, Oregon, 318; Un Oregon, 319; Yaquina Bay, Oregon, 320; Tillamook Bay and Bar, Upper Columbia and Snake rivers, Oregon and Wash., 322; Chehalis R 323; Skagit, Steilaquamish, Nootsack, Snohomish, and Snoqualmie ri 323; examinations and surveys, 324.

IN CHARGE OF MAJ. THOMAS H. HANDBURY, CORPS OF ENGINEERS—

Mouth of the Columbia River, Oregon and Wash., 325; construction of Cascades, Columbia River, Oregon, 326; Columbia and Lower Willa below Portland, Oregon, 327; Willamette River above Portland, C Cowlitz River, Wash., gauging waters of the Columbia River, Oreg tion and survey, 329.

SUPERVISION OF THE HARBOR OF NEW YORK ..

MISSISSIPPI RIVER COMMISSION .....

MISSOURI RIVER COMMISSION .....

HARBOR LINES.

Boston Harbor, Mass., 331; Stamford Harbor, Conn., Hudson River from Baltimore, N. Y., New York Harbor and adjacent waters, 332; James from Richmond to City Point, Norfolk and Portsmouth harbors, Va., waters, 333; Fernandina Harbor, Fla., Quincy Bay, Ill., San Franci and adjacent waters, Cal., in front of San Diego and Coronado, Cal.,

BRIDGING NAVIGABLE WATERS OF THE UNITED STATES.

(1) Bridge operated by Philadelphia, Wilmington and Baltimore Railroad Company over Broad Creek, near Laurel, Del.; (2) bridge of Louisville and Jeffersonville Bridge Company across Ohio River between Louisville, Ky., and Jeffersonville, Ind., 335; (3) bridge of towns of North Hero and Grand Isle, Vt., across channel in Lake Champlain between islands of North Hero and South Hero, Vt.; (4) bridge of Muscatine Bridge Company across Mississippi River at or near Muscatine, Iowa; (5) bridge of Alabama Great Northwestern Railway Company, afterward Montgomery, Tuscaloosa and Memphis Railway Company, across Alabama River, near Montgomery, Ala.; (6) bridges of commissioners of Muskingum County, Ohio, across Muskingum River at Zanesville and near mouth of Brush Creek about 5 miles below Zanesville, Ohio; (7) bridge of Tennessee Midland Railway Company across Tennessee River at Perryville, Tenn., between the counties of Decatur and Perry, Tenn.; (8) bridge of city of La Crosse, Wis., across Mississippi River, at La Crosse, Wis.; (9) bridge of Wheeling Bridge Company across Ohio River at Wheeling, W. Va., 336; (10) bridge of Nashville and Knoxville Railroad Company across Caney Fork River, between Smith and Putnam counties, Tenn.; (11) bridge of New Orleans, Natchez and Fort Scott Railway Company across Tensas River at or near Daniel's Ferry, La.; (12) bridge of St. Louis, Keokuk and Northwestern Railroad Company across Missouri River at Bellefontaine Bluffs, below St. Charles, Mo.; (13) bridge of West Virginia and Ironton Railroad Company across Ohio River about 1¼ miles above mouth of Big Sandy River and about 1 mile below Ceredo, W. Va.; (14) bridge of Kansas City, Arkansas and New Orleans Railway Company across Arkansas River at or near Cumming's Landing, Ark.; (15) bridge of Nebraska Central Railway Company across Missouri River at Omaha, Nebr.; (16) bridge of city of Nebraska City, Nebr., across Missouri River at or near Nebraska City, Nebr.; (17) bridge of Lyons and Fulton Bridge Company across Mississippi River at or near Lyons, Iowa, 337; (18) bridge of Kansas and Arkansas Valley Railway Company across Arkansas River in Indian Territory at or near Fort Smith, Ark.; (19) bridge of city of Michigan City, Ind., across Trail Creek, in Michigan City, Ind.; (20) bridge of Pacific Short Line Bridge Company across Missouri River at or near Sioux City, Iowa, 338.

BRIDGES OBSTRUCTING NAVIGATION.

(1) Across Mississippi River, above Hannibal, Mo., 338; at Keokuk Iowa; (2) across Tennessee River, at Florence, Ala., 339; at Johnsonville, Tenn.; (3) across Charles River, Mass.; (4) across Taunton River at Somerset, Mass.; (5) across St. Joseph River, Mich., near its mouth, 340; (6) across Muskingum River, between Beverly and Waterford, Ohio; at Zanesville, Ohio; over the Lowell Canal, Ohio; (7) across White River, Ind., at Rogers, Ind., at or near Hazelton, Ind., 341; (8) across St. Louis River from Grassy Point, Minn.; (9) across Kentucky River, at Frankfort, Ky.; at Worthville, Ky.; (10) across Moodna or Murderer's Creek, Cornwall, N. Y.; (11) across St. Francis River, Ark., 342; (12) across Ocmulgee River, near Lumber City, Ga.; below Macon, Ga.; at Hawkinsville, Ga.; (13) across Lumber River, N. C.; (14) across channel to Back Cove, Portland, Me.; (15) across Missisquoy Bay, Vt., 343; (16) across Oconee River near Mount Vernon, Ga.; (17) across Harlem River, New York City, 344.

OCCUPANCY OF AND INJURY TO PUBLIC WORKS BY CORPORATIONS AND INDIVIDUALS..... 344

MISCELLANEOUS.

WASHINGTON AQUEDUCT.

IN CHARGE OF LIEUT. COL. GEORGE H. ELLIOTT, CORPS OF ENGINEERS—

Washington Aqueduct, 345; water supply, District of Columbia, 346; increasing water supply of Washington, D. C., erection of fish-ways at Great Falls, 348.

PUBLIC BUILDINGS AND GROUNDS AND WASHINGTON MONUMENT, DISTRICT OF COLUMBIA.

IN CHARGE OF MAJ. O. H. ERNST, CORPS OF ENGINEERS, COLONEL, U. S. A.... 349

SURVEY OF ROAD FROM THE AQUEDUCT BRIDGE TO MOUNT VERNON, VIRGINIA.

IN CHARGE OF LIEUT. COL. PETER C. HAINS, CORPS OF ENGINEERS..... 350

SURVEY OF THE NORTHERN AND NORTHWESTERN

Survey and location of reef near mouth of Gooseberry River, north sh perior, 350.

WATER-LEVEL OBSERVATIONS FOR LAKE ERI

IN CHARGE OF MAJ. L. COOPER OVERMAN, CORPS OF ENGINEERS..

PRINTING AND DISTRIBUTION OF CHARTS OF THE NO NORTHWESTERN LAKES.....

CONSTRUCTION AND IMPROVEMENT OF ROADS AND BRI YELLOWSTONE NATIONAL PARK.

IN CHARGE OF MAJ. WILLIAM A. JONES, CORPS OF ENGINEERS....

MILITARY AND OTHER MAPS.....

MAPS OF BATTLE-FIELDS.....

RECONNAISSANCES AND EXPLORATIONS.

Officers on duty in military divisions and departments, 354; operati ment of the Columbia, Division of the Missouri, Department of the of the Pacific, 355.

ESTIMATE FOR AMOUNT REQUIRED FOR SURVEYS AND SANCES IN MILITARY DIVISIONS AND DEPARTME

OFFICE OF THE CHIEF OF ENGINEERS.

Officers in charge of divisions.....

STATEMENT SHOWING RANK AND DUTIES OF OFFI

FORTIFICATIONS, ETC.

APPENDIX No. 1.

REPORT OF COL. DAVID C. HOUSTON, CORPS OF ENG

IMPROVEMENTS.—*a.* Sea-wall at David's Island, New York Harbor, 3 at Governor's Island, New York Harbor, 383.

APPENDIX No. 2.

REPORT OF LIEUT. COL. PETER C. HAINS, CORPS OF EN

IMPROVEMENTS.—*a.* Wharf at Fort Monroe, Va., 385; *b.* Bridge over Fort Monroe, Va., 387.

APPENDIX No. 3.

REPORT OF LIEUT. COL. WILLIAM R. KING, CORPS OF E

Post of Willets Point, N. Y., 389; Engineer School of Application, 39 Engineers, 393; recruiting, 394; drills and instruction, 397; Enginee buildings and constructions, 398; depot property, 399; photograp experiments, 401; statement of funds, 404; estimates, 406. Appe gramme of study and instruction for summer season, 407; B, progr and instruction for winter season, 409; C, programme of study and summer season, 411; D, ring-firing experiments with a new explosi Colonel Alexander, of Washington, D. C., 413; E, report of Lieut. Corps of Engineers, on results of tests of power of various explosi port of Lieut. Chester Harding, Corps of Engineers, on results of the sensitiveness of explosives, 418; H, reports of Capt. Solomon W. of Engineers, on tests of insulated cable, 419; I, reports of Lieut. Alb Corps of Engineers, on tests of building materials, 421.

RIVERS AND HARBORS, ETC.

APPENDIX A.

REPORT OF LIEUT. COL. JARED A. SMITH, CORPS OF ENGINEERS.

IMPROVEMENTS.—Lubec Channel, Me., Moose-a-bec Bar, Me., 428; Narragaugus River, Me., 429; breakwater from Mount Desert to Porcupine Island, Me., 430; Bagaduce River, Me., Penobscot River, Me., 432; Belfast Harbor, Me., 435; Camden Harbor, Me., 436; Rockport Harbor, Me., 437; Rockland Harbor, Me., 438; Kennebec River, Me., 442; Portland Harbor, Me., 444; channel in Back Cove, Portland, Me., 445; breakwater at mouth of Saco River, Me., 446; Saco River, Me., 447; Kennebunk River, Me., 449; York Harbor, Me., Portsmouth Harbor, N. H., 450; Bellamy River, N. H., 452; Cocheco River, N. H., 453; harbor of refuge at Little Harbor, N. H., 454.

EXAMINATIONS AND SURVEYS.—Belfast Harbor, Me., 455; Union River and Union River Bay, Me., 458; St. Croix River, Me., 463; Pleasant River, from Columbia Falls to its mouth, Me., 467; Kennebunk River, Me., 471; Cocheco River, N. H., from Dover to its mouth, 475.

APPENDIX B.

REPORT OF LIEUT. COL. S. M. MANSFIELD, CORPS OF ENGINEERS.

IMPROVEMENTS.—Newburyport Harbor, Mass., 482; Merrimac River, Mass., 484; Powow River, Mass, 485; Ipswich River, Mass., 487; harbor of refuge, Sandy Bay, Cape Ann, Mass., 488; Gloucester Harbor, Mass., 491; Manchester Harbor, Mass., 493; Lynn Harbor, Mass., 494; Winthrop Harbor, Mass., 496; Boston Harbor, Mass., 497; Hingham Harbor, Mass., 506; Scituate Harbor, Mass., 508; Plymouth Harbor, Mass., 510; Wellfleet Harbor, Mass., 512; Provincetown Harbor, Mass., 513; removal of sunken vessels or craft obstructing or endangering navigation, 516.

EXAMINATIONS AND SURVEYS.—Crane and Waters rivers of Essex Branch, Mass., 517; Weymouth (Fore) River, Mass., 521; Beverly Harbor, Mass., 524; Salem Harbor, including South River, Mass., 528.

HARBOR LINES.—Establishment of harbor lines at Boston Harbor, Mass., 532.

APPENDIX C.

REPORT OF MAJ. WILLIAM R. LIVERMORE, CORPS OF ENGINEERS.

IMPROVEMENTS.—Harbor of refuge at Hyannis, Mass., 552; harbor of refuge at Nantucket, Mass., 554; Vinyard Haven Harbor, Mass., 556; Wareham Harbor, Mass., 558; New Bedford Harbor, Mass., 560; Taunton River, Mass., 563; Warren River, R. I., 565; Pawtucket River, R. I., 566; Providence River and Narragansett Bay, R. I., 568; removal of Green Jacket Shoal, Providence River, R. I., 571; Newport Harbor, R. I., 572; harbor of refuge at Block Island, R. I., 575; Pawcatuck River, R. I. and Conn., 578; harbor of refuge at Stonington, Conn., 581; removing sunken vessels or craft obstructing or endangering navigation, 583.

EXAMINATIONS AND SURVEYS.—Martha's Vineyard, inner and outer harbor at Edgartown, Mass., 585; cove near southeast extremity of Coaster's Harbor Island, R. I., 590; coast near life-saving station, East Point Judith, R. I., 592; Narragansett Bay at the mouth of Narrow River, R. I., 595.

APPENDIX D.

REPORT OF COL. D. C. HOUSTON, CORPS OF ENGINEERS.

IMPROVEMENTS.—Thames River, Conn., 600; New London Harbor, Conn., 604; Connecticut River, Mass. and Conn., 606; Clinton Harbor, Conn., 616; New Haven Harbor, Conn., 617; breakwater at New Haven, Conn., 622; Milford Harbor, Conn., 626; Housatonic River, Conn., 631; Bridgeport Harbor, Conn., 636; Black Rock Harbor, Conn., 640; Norwalk Harbor, Conn., 643; Five Mile River Harbor, Conn., 646; Stamford Harbor, Conn., 648; Port Chester Harbor, N. Y., 650; Echo Harbor, New Rochelle, N. Y., 652; New Rochelle Harbor, N. Y., 654; East Chester Creek, N. Y., 656; Greenport Harbor, N. Y., 660; Glen Cove Harbor, N. Y., 662; Flushing Bay, N. Y., 664; removing sunken vessels or craft obstructing or endangering navigation, 667.

EXAMINATIONS AND SURVEYS.—Brown's Creek, Sayville, N. Y., 669; Larchmont Harbor, N, Y., 675.

HARBOR LINES.—Establishment of harbor lines at Stamford Harbor, Conn., 682.

APPENDIX E.

REPORT OF LIEUT. COL. GEORGE L. GILLESPIE, CORPS OF ENGINEERS.

IMPROVEMENTS.—Hudson River, N. Y., 688; harbor of Saugerties, N. Y., 699; harbor of Rondout, N. Y., 701; Harlem River, N. Y., 705; removing obstructions in East River and Hell Gate, N. Y., 713; Newtown Creek, N. Y., 720; Buttermilk Channel, N. Y., 724; Gowanus Bay, N. Y., 727; New York Harbor, N. Y., 732; Raritan Bay, N. J., 753.

EXAMINATIONS AND SURVEYS.—Wappinger's Creek, from Wappinger's Falls to its mouth, N. Y., 758; East River, with a view to the removal of a ledge of rocks in the same, from the foot of Broome street to the foot of Twenty-third street, in New York City, 761.

HARBOR LINES.—Establishment of harbor lines in Hudson River, from Troy to Coxsackie, N. Y., 766; establishment of harbor lines of New York Harbor and its adjacent waters, 786.

APPENDIX F.

REPORT OF CAPT. THOMAS L. CASEY, CORPS OF ENGINEERS.

IMPROVEMENTS.—Sheepshead Bay, N. Y., 837; Canarsie Bay, N. Y., 839; Sumpawanus Inlet, N. Y., 841; Arthur Kill, N. Y. and N. J., 843; channel between Staten Island and New Jersey, 846; Passaic River, N. J., 848; Elizabeth River, N. J., 852; Rahway River, N. J., 853; Raritan River, N. J., 855; South River, N. J., 858; Shrewsbury River, N. J., 860; Keyport Harbor, N. J., 863.

APPENDIX G.

REPORT OF MAJ. CHARLES W. RAYMOND, CORPS OF ENGINEERS.

IMPROVEMENTS.—Delaware River, Pa. and N. J., 866; harbor between Philadelphia, Pa., and Camden, N. J., 882; Schuylkill River, Pa., 884; ice harbor at Marcus Hook, Pa., 886; ice harbor at head of Delaware Bay, Del., 887; construction of iron pier in Delaware Bay, near Lewes, Del., 888; harbor at Delaware Breakwater, Del., 889; Mantua Creek, N. J., removal of wrecks from Delaware Bay and River, 904; removing sunken vessels or craft obstructing or endangering navigation, 905.

EXAMINATION AND SURVEY.—Alloway Creek, N. J., 906.

APPENDIX H.

REPORT OF WILLIAM F. SMITH, UNITED STATES AGENT, MAJOR OF ENGINEERS, U. S. ARMY, RETIRED.

IMPROVEMENTS.—Maurice River, N. J., 916; Wilmington Harbor, Del., 917; ice harbor at New Castle, Del., 921; Duck Creek, Del., 923; St. Johns River, Del., 925; Mispillion Creek, Del., 927; Broadkiln River, Del., 928; inland waterway from Chincoteague Bay, Va., to Delaware Bay, at or near Lewes, Del., 930; Broad Creek, Del., 933; Susquehanna River above and below Havre de Grace, Md., 934; Fairlee Creek, Md., 936; Corsica Creek, Md., 937; Choptank River, Md., 938; harbor at Cambridge, Md., 940; removing sunken vessels or craft obstructing or endangering navigation, 942.

EXAMINATIONS AND SURVEYS.—Appoquinimink Creek, Del., 943; Wicomico River, Md., 947; North East River, Md., 951; Chester River between Crumpton and Jones' Landing, Md., 954; Manokin River, Md., 959; Elk River, Md., 965; Onancock Harbor, Va., 968; harbor of Cape Charles City and approaches by Cheuton Inlet, Va., 971; Chincoteague Inlet, Va., 980.

APPENDIX I.

REPORT OF COL. WILLIAM P. CRAIGHILL, CORPS OF ENGINEERS.

IMPROVEMENTS.—Patapsco River and channel to Baltimore, Md., 987; James River, Va., 992.

HARBOR LINES.—Establishment of harbor lines in James River from Richmond to City Point, Va., 1012.

APPENDIX J.

REPORT OF LIEUT. G. J. FIEBEGER, CORPS OF ENGINEERS.

IMPROVEMENTS.—Harbor at Norfolk and its approaches, Va., 1021; approach to Norfolk Harbor and United States (Norfolk) navy-yard, between Lambert's Point and Fort Norfolk, Va., 1023; Nansemond River, Va., 1024; Appomattox River, Va., 1025; North Landing River, Va. and N. C., Currituck Sound, Coanjok Bay, and North River Bar, N. C., 1027; removing sunken vessels or craft obstructing or endangering navigation, 1029.

HARBOR LINES.—Establishment of harbor lines of Norfolk and Portsmouth harbors and vicinity, Va., 1030.

PART II.

APPENDIX K.

REPORT OF LIEUT. COL. PETER C. HAINS, CORPS OF ENGINEERS.

IMPROVEMENTS.—Potomac River at Washington, D. C., 1037; construction of bridge across Eastern Branch of Potomac River, D. C., 1048; special report on Shenandoah River, W. Va., 1050.

APPENDIX L.

REPORT OF MR. S. T. ABERT, UNITED STATES AGENT.

IMPROVEMENTS.—Patuxent River, Md., 1060; channel at Mount Vernon, Va., 1061; Breton Bay, Leonardtown, Md., 1062; Nomini Creek, Va., 1063; harbor at entrance of St. Jerome's Creek, Md., 1064; Rappahannock River, Va. (including Urbana Creek), 1065; Totusky River, Va., 1071; Mattaponi River, Va., 1072; Pamunky River, Va., 1074; York River, Va., 1076; Chickahominy River, Va., 1079; Staunton River, Va. (from Pig River to Randolph), 1081; Dan River, N. C. and Va., 1083; removing sunken vessels or craft obstructing or endangering navigation, 1084.

EXAMINATIONS AND SURVEYS.—Chickahominy Creek (River), Va., 1085; Occoquan Creek, Va., 1089; Aquia Creek, Va., 1096.

APPENDIX M.

REPORT OF CAPT. WILLIAM H. BIXBY, CORPS OF ENGINEERS.

IMPROVEMENTS.—Roanoke River, N. C. and Va., 1106; Pamlico and Tar rivers, N. C., 1112; Contentnia Creek, N. C., 1115; Trent River, N. C., 1119; Neuse River, N. C., 1122; inland waterway between New Berne and Beaufort, N. C., 1127; harbor at Beaufort, N. C., 1131; inland waterway between Beaufort Harbor and New River, N. C., 1138; New River, N. C., 1141; Black River, N. C., 1145; Cape Fear River, above Wilmington, N. C., 1148; Cape Fear River, at and below Wilmington, N. C., 1152; Yadkin River, N. C., 1161; harbor at Georgetown, S. C., 1165; Winyaw Bay, S. C., 1169.

EXAMINATIONS AND SURVEYS.—Roanoke River, Va., from Clarksville to Eaton Falls, 1175; Fishing Creek, N. C., 1179; North East River (Cape Fear), N. C., 1181; Shallotte River, N. C., 1184.

APPENDIX N.

REPORT OF CAPT. FREDERIC V. ABBOT, CORPS OF ENGINEERS.

IMPROVEMENTS.—Charleston Harbor, S. C., 1190; Lumber River, N. C., 1198; Mingo Creek, S. C., 1200; Clark Creek, S. C., 1203; Ashley River, S. C., 1205; Edisto River, S. C., 1206; Salkahatchie River, S. C., 1209; Little Pee Dee River, S. C., 1212; Great Pee Dee River, S. C., 1215; Santee River, S. C., 1218; Wateree River, S. C., 1222; Congaree River, S. C., 1224; Wappoo Cut, S. C., 1227; Waccamaw River, N. C. and S. C., 1229; removing sunken vessels or craft obstructing or endangering navigation, 1233.

EXAMINATIONS AND SURVEYS.—Beaufort River, S. C., 1234; Owendaw and Wando rivers and other waters and water routes connecting Bull's Bay and the harbor of Chafleston, S. C., 1239.

APPENDIX O.

REPORT OF LIEUT. O. M. CARTER, CORPS OF ENGINEERS.

IMPROVEMENTS.—Savannah Harbor and River, Ga., 1245; Savannah River, Ga., 1324; Savannah River above Augusta, Ga., 1365; Romley Marsh, Ga., 1367; Altamaha River, Ga., 1369; Oconee River, Ga., 1388; Ocmulgee River, Ga., 1395; Brunswick Harbor, Ga., 1404; Jekyl Creek, Ga., 1420; Cumberland Sound, Ga. and Fla., 1422.
EXAMINATIONS AND SURVEYS.—Oconee River, Ga., 1430; Ocmulgee River, Ga., 1455; Savannah River above Augusta, Ga., and protection of Augusta from floods, 1484.
HARBOR LINES.—Establishment of harbor lines at Fernandina Harbor, Fla., 1545.

APPENDIX P.

REPORT OF CAPT. WILLIAM M. BLACK, CORPS OF ENGINEERS.

IMPROVEMENTS.—St. John's River, Fla., 1549; Volusia Bar, Fla., 1564; harbor at St. Augustine, Fla., 1566; northwest entrance to Key West Harbor, Fla., 1578; Caloosahatchie River, Fla., 1596; Pease River, Fla., 1600; Manatee River, Fla., 1602; Tampa Bay, Fla., 1604; Withlacoochie River, Fla., 1606; harbor at Cedar Keys, Fla., 1609; Suwanee River, Fla., 1611; removing sunken vessels or craft obstructing or endangering navigation, 1614.
EXAMINATION AND SURVEY.—Sarasota Bay, Fla., 1615.

APPENDIX Q.

REPORT OF CAPT. PHILIP M. PRICE, CORPS OF ENGINEERS.

IMPROVEMENTS.—Apalachicola River, Fla., 1621; Apalachicola Bay, Fla., 1623; La Grange Bayou, Fla., 1625; Pensacola Harbor, Fla., 1627; Choctawhatchee River, Fla. and Ala., 1631; Escambia and Conecuh rivers, Fla. and Ala., 1634; Flint River, Ga., 1637; Coosa River, Ga. and Ala., 1640; Chattahoochee River, Ga. and Ala., 1645; Tallapoosa River, Ala., 1649; Cahaba River, Ala., 1651; Alabama River, Ala., 1654; operating and care of canals and other works of navigation on the Coosa River, Ga. and Ala., 1658.
EXAMINATION AND SURVEY.—Coosa River, Ala., from the rapids at Wetumka, to connect with the improvements already completed on said river above the Ten Islands, 1658.

APPENDIX R.

REPORT OF MAJ. A. N. DAMRELL, CORPS OF ENGINEERS.

IMPROVEMENTS.—Mobile Harbor, Ala., 1692; Black Warrior River, Ala., 1696; Warrior and Tombigbee rivers, Ala. and Miss., 1698; Noxubee River, Miss., 1704; Pascagoula River, Miss., 1706; Biloxi Harbor, Miss., 1709; Pearl River, Miss., between Edinburgh and Carthage, 1711; Pearl River, Miss., from Jackson to Carthage, 1713; Pearl River, Miss., below Jackson, 1714.
EXAMINATIONS AND SURVEYS.—Warrior River, Ala., from Tuscaloosa to Demopolis; Tombigbee River, Ala. and Miss., from its mouth up to Vienna, and Tombigbee River between Vienna and Cotton Gin, 1716; Sipsey River, Ala., from the Tombigbee River at Vienna to Texas, with a view of easy transportation of coal, 1722.

APPENDIX S.

REPORT OF CAPT. W. L. FISK, CORPS OF ENGINEERS.

INSPECTION of the improvement at the South Pass of the Mississippi River, 1725.

APPENDIX T.

REPORT OF CAPT. W. L. FISK, CORPS OF ENGINEERS.

IMPROVEMENTS.—Tchefuncte River and Bogue Falia, La., 1737; Tickfaw River and its tributuaries, La., 1739; Amite River, La., 1740; Bayou La Fourche, La., 1742; Bayou Terre Bonne, La., 1745; Bayou Plaquemine, La., 1746; Bayou Courtableau, La., 1747; Calcasieu River and Pass, La., 1750; Sabine River, La. and Tex., 1752; Neches River, Tex., Sabine Pass, Tex., 1753.

CONTENTS.

APPENDIX U.

REPORT OF CAPT. DAN C. KINGMAN, CORPS OF ENGINI

IMPROVEMENT.—Securing mouth of Bayou Plaquemine, La., from fu 1761.

APPENDIX V.

REPORT OF MAJ. CHAS. J. ALLEN, CORPS OF ENGINE

IMPROVEMENTS.—Entrance to Galveston Harbor, Tex., 1767; deep har west coast of Gulf of Mexico, 1781; ship-channel in Galveston Ba Trinity River, Tex., 1802; Buffalo Bayou, Tex., 1807; Aransas Pass a Rockport and Corpus Christi, Tex., 1810; harbor at Brazos Santiago
EXAMINATION AND SURVEY.—Removal of bar at mouth of Cedar Ba empties into Galveston Bay, Tex., 1815.

PART III.

APPENDIX W.

REPORT OF CAPT. JOSEPH H. WILLARD, CORPS OF ENG

IMPROVEMENTS.—Red River, La. and Ark., 1820; Ouachita and Black and La., 1871; Ouachita River, Ark., above Camden, 1878; Bayou D 1879; Little River, La., 1881; Bayou Bartholomew, La. and Ark., Bœuf, La., 1885; Tensas River and Bayou Macon, La., 1888; Big Black 1890; Yazoo River, Miss., 1892; Tchula Lake, Miss., 1896; Tallah Miss., 1897; Steele's Bayou, Miss., 1900; Big Sunflower River, Miss., 1 chee River, Tenn., 1904; Forked Deer River, Tenn., 1906; water-g Mississippi River and its principal tributaries, 1908; special repor Bayou and the lakes between Jefferson, Tex., and Shreveport, La., 1

APPENDIX X.

REPORT OF CAPT. H. S. TABER, CORPS OF ENGINEE

IMPROVEMENTS.—Red River above Fulton, Ark., 1925; Little Red Riv removing obstructions in Arkansas River, Ark., 1928; Arkansas Rive Petit Jean River, Ark., 1939; Fourche River, Ark., 1941; White Rive Cache River, Ark., 1946; Black River, Ark. and Mo., 1948; Black Riv St. Francis River, Ark., 1952; St. Francis River, Mo., 1954; Little R Ark., 1956.

APPENDIX Y.

REPORT OF MAJ. A. M. MILLER, CORPS OF ENGINEI

IMPROVEMENTS.—Removing snags and wrecks from the Mississippi Riv sissippi River between the Ohio and Illinois rivers, 1964; Gasconad 1989; Osage River, Mo., 1992.
SURVEY.—Osage River, Mo., from its mouth to the first shoal, and 5 m same, 1995.

APPENDIX Z.

REPORT OF MAJ. E. H. RUFFNER, CORPS OF ENGINE

IMPROVEMENT.—Mississippi River, between the Des Moines Rapids a of the Illinois River, 2005.
HARBOR LINES.—Establishment of harbor lines of Quincy Bay, Ill., 2(

APPENDIX A A.

REPORT OF MAJ. ALEXANDER MACKENZIE, CORPS OF EN

IMPROVEMENTS.—Operating snag boats and dredge boats on the Uppe River, 2021; Mississippi River from Minneapolis to Des Moines Rapi Moines Rapids, Mississippi River, 2060; operating and care of Des M Canal, 2064; dry dock at Des Moines Rapids Canal, 2070; harbor of re Pepin, at Stockholm, Miss., 2072.

APPENDIX B B.

REPORT OF MAJ. WILLIAM A. JONES, CORPS OF ENGINEERS.

IMPROVEMENTS.—Mississippi River above the Falls of St. Anthony, Minn., 2077; reservoirs at headwaters of the Mississippi River, 2080; Chippewa River, including Yellow Banks, Wis., 2084; St. Croix River, Wis. and Minn., 2087; Minnesota River, Minn., 2090; Red River of the North, Minn. and Dak., 2093; surveys for reservoirs at the sources of the Mississippi, St. Croix, Chippewa, and Wisconsin rivers, Yellowstone River, Mont. and Dak., 2098; gauging Mississippi River at or near St. Paul, Minn., 2099.

APPENDIX C C.

REPORT OF LIEUT. COL. J. W. BARLOW, CORPS OF ENGINEERS.

IMPROVEMENTS.—Tennessee River, 2111; French Broad River, Tenn., 2127; Hiawassee River, Tenn., 2130; Clinch River, Tenn., 2131; Cumberland River, Tenn. and Ky., 2133; South Fork of Cumberland River. Ky., 2148; Caney Fork River, Tenn., 2149.

EXAMINATION AND SURVEY.—Lower Cumberland River, Tenn., from Nashville to its mouth, to ascertain if necessary to establish locks and dams, 2151.

APPENDIX D D.

REPORT OF LIEUT. COL. WILLIAM E. MERRILL, CORPS OF ENGINEERS.

IMPROVEMENTS.—Ohio River, 2164; report on Livingston Point, Ky., 2183; operating and care of Davis Island Dam, Ohio River, 2186; Monongahela River, W. Va. and Pa., 2190; operating and care of Locks and Dams Nos. 8 and 9, Monongahela River, 2192; purchase of Lock and Dam No. 7, Monongahela River, 2193; Allegheny River, Pa., 2194; dam at Herr's Island, Allegheny River, ice harbor at mouth of Muskingum River, Ohio, 2198; Muskingum River, Ohio, 2200; operating and care of locks and dams on Muskingum River, Ohio, 2101.

APPENDIX E E.

REPORT OF CAPT. EDWARD MAGUIRE, CORPS OF ENGINEERS.

IMPROVEMENTS.—Falls of the Ohio River, Louisville, Ky., 2111; Indiana Chute, Falls of the Ohio River, 2215; operating and care of Louisville and Portland Canal, 2221; Wabash River, Indiana and Illinois, 2229; White River, Ind., 2234.

APPENDIX F F.

REPORT OF COL. WILLIAM P. CRAIGHILL, CORPS OF ENGINEERS.

IMPROVEMENTS.—Great Kanawha River, W. Va., 2237; operating and care of locks and dams on Great Kanawha River, W. Va., 2246; Elk River, W. Va., 2247; Gauley River, W. Va., 2248; New River, Va. and W. Va., 2249.

APPENDIX G G.

REPORT OF MAJ. D. W. LOCKWOOD, CORPS OF ENGINEERS.

IMPROVEMENTS.—Tradewater River, Ky., 2253; operating and keeping in repair locks and dams on the Green and Barren rivers, Ky., 2255; Kentucky River, Ky., 2261; operating and keeping in repair locks and dams on Kentucky River, Ky., 2166; Licking River, Ky., from Farmers to West Liberty, 2273; Big Sandy River, W. Va. and Ky., 2274; Guyandotte River, W. Va., 2276; Little Kanawha River, W. Va., 2278; Buckhannon River, W. Va., 2279.

CONTENTS.

APPENDIX H H.

REPORT OF MAJ. JAMES B. QUINN, CORPS OF ENG

IMPROVEMENTS.—Harbor at Grand Marais, Minn., 2282; harbor at A 2283; harbor at Duluth, Minn., 2285; harbor at Superior Bay an Wis., 2291; harbor at Ashland, Wis., 2295; harbor at Ontonag Eagle Harbor, Mich., 2299; harbor at Marquette, Mich., 2300; ha Grand Marais, Mich., 2303.

EXAMINATIONS AND SURVEYS.—Minnesota Point, at Superior, at Lake Superior, Wis, 2306; Duluth, Minn., 2310.

HARBOR LINES.—Establishment and maintenance of harbor lines i Mich., 2323.

APPENDIX I I.

REPORT OF MAJ. CHARLES E. L. B. DAVIS, CORPS OF E

IMPROVEMENTS.—Manistique Harbor, Mich., 2326; Cedar River Har Menomonee Harbor, Mich. and Wis., 2328; Oconto Harbor, Wis., Harbor, Wis., 2333; Green Bay Harbor, Wis., 2334; harbor of refu Sturgeon Bay Canal, Wis., 2336; Ahnapee Harbor, Wis., 2338; Ke Wis., 2340; Two Rivers Harbor, Wis., 2342; Manitowoc Harbor, boygan Harbor, Wis., 2346; Port Washington Harbor, Wis., 2349; at Milwaukee Bay, Wis., 2351; Milwaukee Harbor, Wis., 2353; Wis., 2356; Kenosha Harbor, Wis., 2360; Waukegan Harbor, Ill. Wisconsin rivers, Wis., 2378.

EXAMINATIONS AND SURVEYS.—Harbor at mouth of Fond du Lac Winnebago, Wis., 2389; Menomonee Harbor, from the waters of Ludington & Co.'s Mill, Wis., 2394.

APPENDIX J J.

REPORT OF CAPT. W. L. MARSHALL, CORPS OF ENG

IMPROVEMENTS.—Chicago Harbor, Ill., 2399; Calumet Harbor, Il River, Ill., 2407; operating and care of La Grange Lock, on the Ill 2574; Calumet River, Ill. and Ind., 2576; location of Illinois and M 2580.

APPENDIX K K.

REPORT OF MAJ. WILLIAM LUDLOW, CORPS OF ENG

IMPROVEMENTS.—General remarks, 2608; Charlevoix Harbor and e Lake, Mich., 2610; Frankfort Harbor, Mich., 2612; harbor of ref Lake, Mich., 2613; Manistee Harbor, Mich., 2616; Ludington Harb Pentwater Harbor, Mich., 2631; White River Harbor, Mich., 2634; bor, Mich., 2636; Grand Haven Harbor, Mich., 2646; Black Lake 2652; Saugatuck Harbor, Mich., 2654; South Haven Harbor, Mic seph Harbor, Mich., 2658; St. Joseph River, Mich., 2661; Michiga Ind., 2662.

EXAMINATIONS AND SURVEYS.—Petoskey Harbor, Mich., 2668; Gran 2676.

APPENDIX L L.

REPORT OF COL. O. M. POE, CORPS OF ENGINEE

IMPROVEMENTS.—St. Mary's River, Mich., 2684; operating and ca Falls Canal, Mich., 2695; dry dock at St. Mary's Falls Canal, Mi Channel, St. Mary's River, Mich., 2714; harbor at Cheboygan, Mic at Thunder Bay, Mich., 2722; harbor at Au Sable, Mich., 2723; Mich., 2724; harbor of refuge at Sand Beach, Lake Huron, Mich., Black River, Mich., 2735; St. Clair Flats Canal, Mich., 2737; operat St. Clair Flats Canal, Mich., 2739; Grosse Pointe Channel, Mich River, Mich., 2742; Detroit River, Mich., 2745; Rouge River, Mi

EXAMINATION AND SURVEY.—Detroit River, at Grosse Pointe, Mi

APPENDIX M M.

REPORT OF MAJ. L. COOPER OVERMAN, CORPS O

IMPROVEMENTS.—Monroe Harbor, Mich., 2753; Toledo Harb
Clinton Harbor, Ohio, 2767; Sandusky City Harbor, Ohio, 27
Ohio, 2771; Huron Harbor, Ohio, 2772; Vermillion Harbor, Oh
Harbor, Ohio, 2775; Cleveland Harbor, Ohio, 2777; Fairport
Ashtabula Harbor, Ohio, 2783; removing sunken vessels or
endangering navigation, 2787.

APPENDIX N N.

REPORT OF MAJ. AMOS STICKNEY, CORPS OF E

IMPROVEMENTS.—Erie Harbor, Pa., 2789; preservation and pro
sula of Presque Isle, Erie Harbor, Pa., 2799; Dunkirk Harbo
Harbor, N. Y., 2808; Tonawanda Harbor and Niagara River
Harbor, N. Y., 2842; Olcott Harbor, N. Y., 2844; Oak Orchar

APPENDIX O O.

REPORT OF MAJ. MILTON B. ADAMS, CORPS OF

IMPROVEMENTS.—Charlotte Harbor, N. Y., 2849; report on ch
Ontario and Irondequoit Bay, N. Y., 2853; Great Sodus Harb
Sodus Harbor, N. Y., 2858; Oswego Harbor, N. Y., 2862; Sac
2868.

APPENDIX P P.

REPORT OF MAJ. MILTON B. ADAMS, CORPS OF

IMPROVEMENTS.—Odgensburgh Harbor, N. Y., 2871; Grass
N. Y., 2874; breakwater at Rouse's Point, Lake Champlain, N.
tween North and South Hero Islands. Lake Champlain, Vt.,
Gordon's Landing, Lake Champlain, Vt., 2877; Plattsburgh
Burlington Harbor, Vt., 2879; Otter Creek, Vt., 2881; Ticon
2882; Narrows at Lake Champlain, N. Y. and Vt., 2883.

PART IV.

APPENDIX Q Q.

REPORT OF COL. G. H. MENDELL, CORPS OF E

IMPROVEMENTS.—Napa River, Cal., 2885; Oakland Harbor, C
San Francisco Harbor, San Pablo and Suisun bays, Strait
mouths of Sacramento and San Joaquin rivers, Cal., 2890.
HARBOR LINES.—Establishment of harbor lines of San Francis
cent waters, 2890.

APPENDIX R R.

REPORT OF LIEUT. COL. W. H. H. BENYAURD, CORP

IMPOVEMENTS.—Redwood Harbor, Cal., 2897; San Luis O
2899; Wilmington Harbor, Cal., 2900; San Diego Harbor, Ca
HARBOR LINES.—Establishment of harbor lines in front of San
Cal., 2904.

APPENDIX S S.

REPORT OF MAJ. WILLIAM H. HEUER, CORPS OF

IMPROVEMENTS.—San Joaquin River, Stockton and Mormon
Mokelumne River, Cal., 2911; Sacramento and Feather riv
luma Creek, Cal., 2917; Humboldt Harbor and Bay, Cal., 291

APPENDIX T T.

REPORT OF CAPT. THOS. W. SYMONS, CORPS OF ENGINEERS.

IMPROVEMENTS.—Coquella River, Oregon, 2924; entrance to Coos Bay, Oregon, 2929; Umpqua River, Oregon, 2965; entrance to Yaquina Bay, Oregon, 2967; Tillamook Bay and Bar, Oregon, 2979; Upper Columbia and Snake rivers, Oregon and Wash., 2981; Chehalis River, Wash., 2984; Skagit, Steilaquamish, Nootsack, Snohomish, and Snoqualmie rivers, Wash., 2986.
EXAMINATIONS AND SURVEYS.—Young's River and its tributary, Klaskuine River, Oregon, 2989; Nehalem Bay and Bar, Oregon, 2993; Siuslaw River and Bar, Oregon, 2999; Umpqua River, Oregon, between Scottsburgh and the mouth, 3005.

APPENDIX U U.

REPORT OF MAJ. THOMAS H. HANDBURY, CORPS OF ENGINEERS.

IMPROVEMENTS.—Mouth of Columbia River, Oregon and Wash., 3011; report on overcoming obstructions in Columbia River at Dalles and Celilo Falls, and at Three and Ten Mile Rapids, 3028; construction of canal at the Cascades, Columbia River, Oregon, 3052; Columbia and Lower Willamette rivers below Portland, Oregon, 3058; Willamette River above Portland, Oregon, 3061; Cowlitz River, Wash., 3063; gauging waters of Columbia River, Oregon, 3064.
EXAMINATION AND SURVEY.—Upper Columbia River, Wash., between Wallula and British line, 3065.

APPENDIX V V.

REPORT OF CAPT. W. A. KIRKLAND, UNITED STATES NAVY.

SUPERVISION of the harbor of New York, 3077.

APPENDIX W W.

REPORT OF THE MISSISSIPPI RIVER COMMISSION.

C. B. COMSTOCK, Colonel of Engineers and Bvt. Brig. Gen., President Mississippi River Commission; CHAS. R. SUTER, Lieut. Col. of Engineers, U. S. A.; O. H. ERNST, Major of Engineers, Col. U. S. A.; HENRY L. WHITING, Assistant U. S. Coast and Geodetic Survey; B. M. HARROD, HENRY FLAD, R. S. TAYLOR, *Commissioners.*

ANNUAL REPORT FOR THE FISCAL YEAR ENDING JUNE 30, 1890..... 3083

APPENDIX A.—Memorandum on the question whether levees cause the river bed to rise, 3093.
APPENDIX B.—Memorandum on outlets, 3105.
APPENDIX C.—Note on flood report of 1890, 3107.
APPENDIX D.—Statement of length and distribution of front levee lines in the alluvial valley of the Mississippi, 3111.
APPENDIX E.—Report of the secretary of the Commission, assistant to construction committee, in charge of the St. Louis office, 3112; regimen elements of Mississippi River, bank-full and medium stages, Cairo to Gulf of Mexico, 3119; report on relation between mean bank height and mean high water, 3137; discharge observations near New Madrid, Mo., 3150; discharge observations at Helena, Ark., 3158; discharge observations at Arkansas City, Ark., 3165; discharge observations at Wilson's Point, La., and at break in Skipwith Levee, Mississippi, 3170; survey of Mississippi River, 3179; general service, 3185.
APPENDIX F.—Report on operations in the first district, 3196.
APPENDIX G.—Report on operations in the second district, 3211.
APPENDIX H.—Report on operations in the third district, 3228.
APPENDIX I.—Report on operations in the fourth district, 3289.

APPENDIX X X.

REPORT OF THE MISSOURI RIVER COMMISSION.

CHARLES R. SUTER, Lieut. Col. of Engineers, U. S. A., President Missouri River Commission;
ALEX. MACKENZIE, Major of Engineers, U. S. A.;
O. H. ERNST, Major of ENGINEERS, U. S. A.;
GARLAND C. BROADHEAD;
WILLIAM J. BROATCH;
Commissioners.

ANNUAL REPORT FOR FISCAL YEAR ENDING JUNE 30, 1890, 3361.

APPENDIX A.—Annual report of Secretary Missouri River Commission, 3367; (1) report on commerce of Missouri River during year 1889, 3370; (2) report on borings in Missouri River Valley, 3375; (3) dates of ice closings and openings on Missouri River, 3392; (4) descriptions and elevations of bench-marks on Missouri River, 3393; (5) report of Mr. O. B. Wheeler, assistant engineer, 3398; (6) report of Mr. G. A. Marr, assistant engineer, 3403.
APPENDIX B.—Annual report of Lieut. Hiram M. Chittenden, Corps of Engineers, 3419.
APPENDIX C.—Annual reports of Mr. Charles F. Potter, division engineer, 3422.
APPENDIX D.—Annual report of Mr. S. Waters Fox, division engineer, 3428.
APPENDIX E.—Annual report of Mr. S. H. Yonge, division engineer, 3435.

APPENDIX Y Y.

BRIDGING NAVIGABLE WATERS OF THE UNITED STATES.

Report of Board of Engineers on Senate bills Nos. 3901 and 3980, Fiftieth Congress, second session, to authorize the construction of bridges across Mississippi River above and below New Orleans, La., 3449; report of Board of Engineers on H. R. bill No. 10437, Fifty-first Congress, first session, to authorize the construction of a high level bridge across Mississippi River at or near the lower limits of the city of New Orleans, La., 3453; report of Board of Engineers respecting the practicability and necessity of a bridge across Detroit River at Detroit, Mich., 3456; report of Board of Engineers on the practicability and approximate cost of tunneling the Detroit River at or near Detroit, Mich., 3462; report of Board of Engineers on plans and location of proposed bridge across Ohio River between Louisville, Ky., and Jeffersonville, Ind., 3465; report of Board of Engineers respecting bridges across Charles River, Mass., interfering with navigation, 3470; report of Board of Engineers on alleged obstruction of navigation by certain bridges over Harlem River, N. Y., 3484.

APPENDIX Z Z.

OCCUPANCY OF AND INJURY TO PUBLIC WORKS BY CORPORATIONS AND INDIVIDUALS.....3489

APPENDIX A A A.

REPORT OF LIEUT. COL. GEORGE H. ELLIOT, CORPS OF ENGINEERS.

IMPROVEMENTS.—Washington Aqueduct, 3501; water supply, District of Columbia, 3522; increasing the water supply of Washington, D. C., 3531; erection of fishways at Great Falls, 3532.

APPENDIX B B B.

REPORT OF COL. O. H. ERNST, U. S. ARMY.

IMPROVEMENT and care of public buildings and grounds in the District of Columbia, 3535; Washington Monument, 3536; telegraph to connect the Capitol with the Departments and Government Printing Office, 3549; Appendix A, catalogue of trees and shrubs in public grounds of Washington, D. C., 3556.

APPENDIX C C C.

REPORT OF LIEUT. COL. PETER C. HAINS, CORPS OF ENGINEERS.

SURVEY of road from Aqueduct Bridge to Mount Vernon, Va., 3563.

APPENDIX D D D.

THE NORTHERN AND NORTHWESTERN LAKES.

REPORT OF MAJ. JAMES B. QUINN, CORPS OF ENGINEERS.

SURVEY and location of danger reef near mouth of Gooseberry River, north shore of Lake Superior, 3583.

REPORT OF MAJ. L. COOPER OVERMAN, CORPS OF ENGINEERS.

WATER-LEVEL OBSERVATIONS for Lake Erie, 3583.

REPORT OF COL. O. M. POE, CORPS OF ENGINEERS.

ISSUE of published charts, 3588.

APPENDIX E E E.

REPORT OF MAJ. WILLIAM A. JONES, CORPS OF ENGINEERS.

CONSTRUCTION and improvement of roads and bridges in the Yellowstone National Park, 3591.

APPENDIX F F F.

EXPLORATIONS AND SURVEYS IN DIVISIONS AND DEPARTMENTS.

REPORT OF MAJ. GARRET J. LYDECKER, CORPS OF ENGINEERS.

EXPLORATIONS and surveys in the Department of the Columbia, 3599.

REPORT OF CAPT. WILLIAM M. MARSHALL, CORPS OF ENGINEERS.

EXPLORATIONS and surveys in the Division of the Missouri, 3600.

REPORT OF LIEUT. CHARLES A. WORDEN, SEVENTH INFANTRY.

EXPLORATIONS and surveys in the Department of the Platte, 3601.

REPORT OF LIEUT. JAMES E. RUNCIE, FIRST ARTILLERY.

EXPLORATIONS and surveys in the Division of the Pacific, 3603.

LAWS AFFECTING THE CORPS OF ENGINEERS, FIFTY-FIRST CONGRESS, FIRST SESSION, 1889–'90 3607

ANNUAL REPORT

OF THE

CHIEF OF ENGINEERS,

UNITED STATES ARMY.

1890.

REPORT

OF

THE CHIEF OF ENGINEERS,

UNITED STATES ARMY.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., October 4, 1890.

SIR: I have the honor to present for your information the following report upon the duties and operations of the Engineer Department for the fiscal year ending June 30, 1890:

OFFICERS OF THE CORPS OF ENGINEERS.

The number of officers holding commissions in the Corps of Engineers, U. S. Army, at the end of the fiscal year was 112.

Since the last annual report the Corps has lost two of its officers, Capt. Eugene Griffin and Lieut. Irving Hale, by resignation October 5, 1889, and April 1, 1890, respectively.

On the 30th of June, 1890, the officers were distributed as follows:

Commanding the Corps of Engineers and the Engineer Department	1
Office of the Chief of Engineers	3
Board of Engineers, fortifications, river and harbor works, and Division Engineer	1
Board of Engineers, Board of Ordnance and Fortification, and Division Engineer	1
Board of Engineers, Mississippi River Commission, Division Engineer, and Board of Visitors	1
Board of Engineers, fortifications, river and harbor works, and Board of Visitors	2
Fortifications, river and harbor works, and Division Engineers	2
Public Buildings and Grounds, Mississippi River Commission, and Missouri River Commission	1
Washington Aqueduct	1
River and harbor works	33
Fortifications, and river and harbor works	22
Mississippi River Commission, and Missouri River Commission	1
Fortifications, Post of Willets Point, Engineer School of Application, and Battalion of Engineers	1
River and harbor works, and Missouri River Commission	1
Battalion of Engineers, and Engineer School of Application	14
Mississippi River Commission	1
Fortifications	1
Battalion of Engineers	2
Leave of absence	2
Sick leave of absence	1
Incapacitated for active service and on indefinite leave of absence	1
Detached, with Board of Commissioners of the District of Columbia, at Military Academy, with General Commanding Military Department, with Light-House Establishment, as military attachés, and with Missouri River Commission	19
	112

The officers detached were on duty as follows:

Lieut. Col. Henry M. Robert, Engineer Commissioner of the District of Columbia	1
Lieut. Col. John M. Wilson, Superintendent Military Academy	1
Maj. Garrett J. Lydecker, Engineer Officer, Department of the Columbia	1
Maj. David P. Heap, engineer third light-house district	1
Maj. William S. Stanton, engineer first and second light-house districts	1
Maj. James C. Post, military attaché to United States legation at London	1
Maj. James F. Gregory, engineer secretary of the Light-House Board	1
Capt. John C. Mallery, engineer fifth and sixth light-house districts	1
Capt. Frederick A. Mahan, engineer fourth light-house district	1
Capts. William T. Rossell and James L. Lusk, assistants to Engineer Commissioner of District of Columbia	2
Capts. George McC. Derby and Lieut. John Biddle, on duty with Company E, Battalion of Engineers, and at Military Academy	2
Capt. Theodore A. Bingham, military attaché to United States legation at Berlin	1
Lieut. John Millis, assistant to engineer third light-house district	1
Lieuts. Lansing H. Beach and Joseph E. Kuhn, on duty at Military Academy	2
Lieut. James C. Sanford, secretary and disbursing officer of Missouri River Commission	1
Lieut. Hiram M. Chittenden, on duty with Missouri River Commission	1
	19

SEA-COAST DEFENSES.

At the close of the fiscal year ending June 30, 1890, no appropriations for construction of works of sea-coast defense had been made since February 10, 1875. The sums appropriated, from time to time, for the preservation and repair of fortifications have been applied to the more urgent work of this character, including, also, the renewal of platforms for heavy artillery practice. While some of the defensive works thus cared for can be utilized in the new system of defense, and thus present special claims for attention, all have some importance as parts of a system, which, though antiquated, forms the only means of land defense, until supplanted by works of modern type. Hence they should not be allowed to go to ruin; an estimate is submitted for their preservation and repair.

The main features of the new works have been presented in my Annual Report for 1889, as embracing armaments of the heaviest rifled guns, submarine mines, and batteries of rapid-firing guns of small caliber for protection of the mined areas. Projects for those works relating to gun defense provide for mortar batteries; barbette batteries of three types, according as they are armed with guns mounted on disappearing carriages, or lifts, or in iron-clad casements, and iron or steel turrets.

The construction of these works, omitting for the present those of iron and the turrets, should keep pace with that of their armaments. Accordingly supplemental estimates were submitted to the Secretary of War February 14, 1890, based on the number of high-power breech-loading rifled guns and mortars, which it was understood the Ordnance Department would have completed by January 1, 1892. It was recommended that emplacements be provided for this ordnance at New York at an estimated cost of $726,000; at Boston, $235,000; and at San Francisco, $260,000; or at a total cost of $1,221,000, this amount to be expended in the construction of the epaulements, magazines, and bomb-proof spaces of the several works, and the funds for this work were provided in the act of August 18, 1890. It is recommended that the additional ordnance, which will be completed by January 1, 1893, be placed in position at the three points named, and also in the defenses at Hampton Roads, Va., and below Washington. It is believed that

two 12-inch, five 10-inch, and six 8-inch rifles, and twenty-seven 12-inch mortars will be available by January 1, 1893, and for their emplacements estimates are submitted as follows: for Boston Harbor, $295,000; New York Harbor, $477,000; Hampton Roads, $188,000; Washington, $190,000, and San Francisco Harbor, $585,000.

As modern heavy rifles have by their increased effective range necessitated the advance of the exterior line of defense to a distance of from 8 to 10 miles from the object of defense, where 1 mile was once more than ample, it will be necessary for the United States to acquire additional sites for defensive works. About 779 acres will be needed at the five points above considered; approximately the same amount will be required at various other points. The amount provided in the act of August 18, 1890, will not be sufficient to purchase the sites needed, and an additional estimate of $500,000 is submitted to aid in their acquirement.

The construction of torpedo-casemates and cable-galleries at defensive works in the harbors at Boston, New York, and San Francisco has continued. Of these casemates two are located at Boston, five at New York, and two at San Francisco; five are essentially completed. The sums appropriated will suffice for the works already commenced. Estimates are submitted for constructing additional works of this character at these and other harbors.

The act of September 22, 1888, made an appropriation of $117,000 for the construction of sea-walls and for earth embankments. With the approval of the Secretary of War this was allotted as follows:

For the preservation of site of Fort Niagara	$20,000
For sea-wall and earth embankment at David's Island, New York Harbor	47,000
For sea-wall at Governor's Island, New York Harbor	50,000

At Fort Niagara operations were delayed until August 10, 1889, by the stage of water in the lake; since that date work has been in progress and still continues; 1,811 linear feet of shore-revetment have been built at a cost of $12,175.05. The balance of the allotment is being applied to closing a breach in the work which threatened to destroy the entire northwest angle and the "French Castle" near by.

The amount allotted will be sufficient to finish this work.

At David's Island the sea-wall has been completed. The embankment will be finished early in the current fiscal year.

(See Appendix 1 A.)

To complete the sea-wall around Governor's Island the original estimate was $100,000, of this amount $50,000 was allotted as above. This has been applied to building a masonry wall about 1,100 feet in length on the north shore of the island, and to filling with earth the space behind the wall. About 20 per cent. of this filling remains to be done. To complete the original project the dry-wall on the southwest side of the island is to be replaced by a masonry wall some 1,500 feet long, for which a sufficient appropriation has been provided in the act of August 18, 1890.

(See Appendix 1 B.)

ESTIMATES OF APPROPRIATIONS REQUIRED FOR 1891-'92.

For construction of gun and mortar batteries at Boston Harbor, New York Harbor, Hampton Roads, Washington, and San Francisco Harbor	$1,735,000
For purchase of land for fortifications	500,000
For protection, preservation, and repair of fortifications	175,000
For preparation of plans for fortifications	5,000
For protection of the shore at Fort Monroe, Va	27,000
For artesian well at Fort Monroe, Va	10,000

For purchase of submarine mines and necessary appliances to operate them for closing the channels leading to our principal sea-ports	$250,000
For needful casemates, cable-galleries, etc., from which to operate submarine mines	250,000
For continuing torpedo experiments, and for practical instruction of Engineer troops in the details of the service	30,000
For construction of a wharf, a keeper's dwelling, and for a water supply for the torpedo station at Yerba Buena Island, California	16,000
	2,998,000

THE BOARD OF ENGINEERS.

The Board of Engineers, as at present constituted, consists of the following officers of the Corps of Engineers: Col. Henry L. Abbot, Col. C. B. Comstock, Col. D. C. Houston, and Lieut. Col. George L. Gillespie.

In addition to the above, Col. George H. Mendell, Corps of Engineers, was, by General Orders No. 8, Headquarters, Corps of Engineers, October 12, 1889, appointed a member of the Board when it is acting upon matters pertaining to the defensive works on the Pacific coast.

The Board has considered the various subjects referred to it during the past year by the Chief of Engineers, and the following brief summary of the reports rendered thereon indicates the laborious character of the duty devolving upon it:

1889, July 3. Relative to reservation at Point Roberts, Washington, for defensive purposes.

July 3. On data to be obtained abroad relative to torpedoes.

July 3. On range and position finder invented by Second Lieut. John W. Ruckmann, Fifth Artillery, and Mr. O. T. Crosby.

July 19. Preliminary report and estimates for defense of San Francisco Bay and the eastern entrance to New York Harbor.

August 1. On the defense of Boston Harbor.

August 14. Relative to modification proposed by Lieut. Col. J. W. Barlow, Corps of Engineers, in the form and style of dam at Lock No. 1, Cumberland River.

August 15. On deep-water mine and submarine shrapnel invented by Lieut. G. F. Elliott, U. S. Marine Corps.

October 21. Relative to location of mining casemate and operating room at Willets Point.

December 5. On torpedo project for Point San José, Cal., prepared by Lieut. H. C. Newcomer, and approved by Col. George H. Mendell, Corps of Engineers.

December 7. On plan of Mr. H. A. Blackwell for moving guns by railway.

December 7. On relinquishment of title by United States to certain lands at Fort Clinch, Fla.

December 7. On acquirement of additional land at Fort Wadsworth, N. Y.

December 21. On project of Col, George H. Mendell, Corps of Engineers, for torpedo-shed at Yerba Buena Island.

December 21. Relative to reservation of land for military purposes on Puget Sound.

December 31. On Senate bill No. 76, Fifty-first Congress, first session, "making an appropriation for the purchase of sites for fortifications."

December 31. On Senate bill No. 1261, Fifty-first Congress, first session, "to authorize the purchase of sites for fortifications in the Division of the Pacific."

December 31. On Senate bill No. 75, Fifty-first Congress, first session, "to provide for fortifications and other works of defense upon Puget Sound, in the State of Washington."

1890, January 2. On Senate bill No. 74, Fifty-first Congress, first session, "to provide for fortifications and other sea-coast defenses."

January 2. On Senate bill No. 1262, Fifty-first Congress, first session, "making appropriations for fortifications and other works of defense on the Pacific coast."

January 23. On shore protection of the peninsula at Erie, Pa.

January 23. On recommendation of Maj. C. J. Allen, Corps of Engineers, on running a line of precise levels connecting the gauges in Galveston Harbor and Bay.

January 27. On use of Fort Taylor, Fla., for a disinfecting station.

February 4. On House bill No. 3886, Fifty-first Congress, first session, authorizing a bridge across the Hudson River at New York City.

February 4. Relative to plan of Capt. William L. Marshall, Corps of Engineers, for operating large locks for gates.

February 17. On House bill No. 6583, Fifty-first Congress, first session, granting the consent of Congress to the erection of bridges over navigable waters.

February 17. On House resolution No. 22, Fifty-first Congress, first session, granting the use of Governor's Island as a public park.

February 27. On Raftery's Harbor "boom gates."

March 4. On number of sites for coast defenses to be purchased at San Francisco and eastern entrance to New York.

March 4. Relative to change of location for dynamite guns from Lovell's Island to Fort Warren.

March 4. Relative to Engineer Department furnishing material to artillery school at Fort Monroe for instruction and experiment in submarine mining.

March 25. On project of Lieut. Col. J. A. Smith, Corps of Engineers, for improving Saco River, Maine.

March 25. On House bill No. 6433, Fifty-first Congress, first session, authorizing the building of bridges by the Virginia, Missouri and Western Railroad Company.

March 25. On need of land fronting Fort Johnston, N. C., for military purposes.

March 28. On the general defenses of Washington, D. C.

Lieut. Col. P. C. Hains, Corps of Engineers, was, by authority of the Secretary of War contained in letter of Chief of Engineers dated January 23, 1890, appointed a member of the Board while the defenses of Washington are under consideration.

March 28. On the submarine defenses of Washington, D. C.

Lieutenant-Colonel Hains being a member, as above.

April 3. On the purchase of Sims-Edison torpedoes.

April 5. On Senate bill No. 3172, Fifty-first Congress, first session, granting use of the Fort Hale tract to the city of New Haven as a public park.

April 7. On purchase of sites for the defenses of New York, Boston, San Francisco, Hampton Roads, and Washington, D. C.

April 12. On petition of citizens of Grand Rapids, Mich., for improving Grand River.

April 12. On modified project of Lieut. Col. J. A. Smith, Corps of Engineers, for improving Rockland Harbor, Maine.

April 12. On invention of Mr. William Dewart for "electric forts."

April 16. On the necessity of a reservation at Port Angeles, Puget Sound, for defensive purposes.

May 8. On House bill No. 933, Fifty-first Congress, first session, granting right of way to the Tacoma and Olympic Railway Company across certain reservations in the State of Washington.

May 10. On House bill No. 9855, Fifty-first Congress, first session, "to prevent injuries to bridges across navigable rivers and lakes, and obstruction to travel across the same."

June 10. On improvements upon the Fort Hale tract proposed by the New Haven park commissioners.

June 21. On House bill No. 10755 and Senate bill No. 4065, Fifty-first Congress, first session, authorizing construction of bridge across the Hudson River between New York City and the Sate of New Jersey.

June 30. On the Halpin-Savage torpedo.

In the performance of the duties of the Board, the following personal examinations were made:

In obedience to Special Orders No. 255, Headquarters of the Army, November 1, 1889, a committee of the Board, consisting of Cols. George H. Mendell and Henry L. Abbot, made a thorough personal inspection of the sites suitable for the defense of San Francisco for the use of the Board in designing the fortifications at that place.

In obedience to Special Orders No. 15, Headquarters of the Army, January 25, 1890, the Board made a personal inspection of sites on the Potomac River for the defense of Washington, D. C.

On June 9, 1890, the Board visited Brooklyn and inspected the Halpin-Savage torpedo, upon which a report had been ordered by the Chief of Engineers.

In addition to their duties with The Board of Engineers the individual members of the Board have been otherwise engaged as follows:

1. Col. Henry L. Abbot, the president of the Board, has continued in charge of certain experiments with torpedoes; as a member of the Board of Ordnance and Fortification; as president of the board to fix the harbor lines for the harbor of New York and its adjacent waters; as president of the board to fix the harbor lines for the port of Boston, and as division engineer of the Northeast Division. Has served as president of boards for the examination of officers of the Corps of Engineers with a view to promotion; was detailed to deliver a course of lectures on coast defense at the Naval War College during the term beginning in September, 1889; was charged with the duty of preparing working drawings and estimates for a gun-lift suited for battery designed by General J. C. Duane; served as president of board to consider bridges across the Charles River owned or controlled by the cities of Boston and Cambridge, and as president of board to investigate and report upon alleged obstructions of navigation by certain bridges over the Harlem River, New York.

2. Col. C. B. Comstock has served as division engineer of the Southwest Division; as member of the board of visitors to the Engineer School of Application; as president of the Mississippi River Commission; as member of the board to fix the harbor lines of New York and its adjacent waters; as member of the board to fix the harbor lines of Philadelphia; as president of the board to report on proposed bridge at Louisville, Ky.; as senior member of two boards to report on proposed bridges at New Orleans, La.; as member of board to report on bridges as obstructions on Harlem River; as member of three boards for examination of officers for promotion.

3. Col. D. C. Houston has been the disbursing officer of The Board of

Engineers. He has conducted the various works of river and harbor improvement and of fortifications under his charge, and has served as a member of the Board of Visitors to the Engineer School of Application; as a member of the board to fix the harbor lines for the harbor of New York and its adjacent waters; as a member of the board to establish harbor lines in Stamford Harbor, Connecticut, and as a member of boards for the examination of certain officers of the Corps of Engineers with a view to promotion.

4. Lieut. Col. G. L. Gillespie, in addition to conducting the various works of river and harbor improvements and of fortifications with which he was charged during the year, has served as a member of the Board of Visitors to the Engineer School of Application; of the boards on harbor lines of New York harbor and adjacent waters, of Stamford Harbor, Connecticut, and of the port of Boston, Mass.; of the boards on bridges across the Charles River owned or controlled by the cities of Boston and Cambridge, Mass., and of certain bridges across the Harlem River, New York, and of board for the examination of officers of the Corps of Engineers with view to their promotion. He was also charged with the supervision of the construction of a Kennon counterpoise battery at Fort Hamilton, N. Y.

WHARF AT FORT MONROE, VIRGINIA.

Lieut. Col. Peter C. Hains, Corps of Engineers, in charge.

The act approved August 4, 1886, providing for the sundry civil expenses of the Government for the fiscal year 1887, contained an appropriation of $100,000 for a new wharf at Fort Monroe, Va. The project adopted was the construction of a wharf on iron piles with iron beams and wooden flooring. By act approved August 10, 1888, an additional appropriation of $75,000 was made for the purpose of enlarging the dimensions of the wharf then in course of construction. Under the provisions of the latter act the plans of the wharf were changed, the principal items being the addition of 42 feet to its length, 28 feet to its width, and the construction of a wooden fender system. The construction of the wharf was well advanced at the close of the fiscal year 1889, and was completed during September, 1889, and thrown open to public use. The total area of the wharf is about 63,500 square feet, or nearly an acre and a half. A store-house is now in course of erection on the wharf and is nearly completed.

July 1, 1889, amount available		$30,619.00
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$50,454.01	
July 1, 1890, outstanding liabilities	697.00	
July 1, 1890, amount covered by uncompleted contracts made during the fiscal year ending June 30, 1890	5,204.67	
July 1, 1890, balance available		28,540.68

(See Appendix 2 A.)

IRON PILE BRIDGE OVER MILL CREEK AT FORT MONROE, VIRGINIA.

Lieut. Col. Peter C. Hains, Corps of Engineers, in charge.

An appropriation of $20,000 for the construction of an iron bridge over Mill Creek, at Fort Monroe, Va., was contained in the act providing for sundry civil expenses of the Government for the fiscal year ending June 30, 1890. The approved project is the construction of an iron pile

bridge, 24 feet wide, on the site of the old wooden structure, without interrupting travel. A contract was made, under date of August 19, 1889, with the Groton Bridge and Manufacturing Company, of Groton, N. Y., for the construction of the bridge at a total price of $17,500. The work was practically completed during May, 1890.

July 1, 1889, amount available		$20,000.00
July 1, 1890, amount expended during fiscal year	$12,291.02	
July 1, 1890, outstanding liabilities	7,632.25	
		19,923.27
July 1, 1890, balance available		76.73

(See Appendix 2 B.)

POST OF WILLETS POINT, NEW YORK—ENGINEER SCHOOL OF APPLICATION, U. S. ARMY—BATTALION OF ENGINEERS—ENGINEER DEPOT.

Officer in command, Lieut. Col. W. R. King, Corps of Engineers.

POST OF WILLETS POINT, NEW YORK.

At the close of the fiscal year the garrison consisted of 28 commissioned officers and 384 enlisted men, including officers and non-commissioned officers of the general staff, student officers, and enlisted men of the Hospital Corps. This is a net increase of 17 men in enlisted strength over last year's report.

Some repairs and improvements have been made during the year to the roads and buildings, and plans have been made for a new coal-shed, which is now being built near the quartermaster's wharf.

The fire-proof building for engineer models is well under way and will be inclosed before winter sets in. Plans and estimates have been made for lighting the public buildings and grounds by electricity, as suggested in last annual report. Two large water-closets have been built for use of enlisted men and some work has been done in grading the parade-ground.

Nearly all these improvements have been made by enlisted men detailed for the purpose.

An allotment has been made for deepening and cleaning out the ditch on the west side of the post, and this much-needed work will be done as soon as practicable.

There is a pressing necessity for new barracks, mess building, and quartermaster and commissary store-houses. The present frame buildings were constructed twenty years ago, when the enlisted strength of the garrison was but 250. Much of the material used in their construction was obtained from condemned buildings at David's Island, and almost all the work was performed by the garrison. The enlisted strength of the garrison, it is seen, is now nearly 400, to be accommodated in buildings provided originally for but five-eighths of that number. It is urged that the needs of this post and its garrison may be considered in the assignment of appropriations for barracks and quarters.

ENGINEER SCHOOL OF APPLICATION, U. S. ARMY.

During the year two engineer officers, one artillery officer, and six infantry officers completed the course, and nine artillery and infantry officers who have completed the laboratory duty are still engaged in the

practice work of planting and operating torpedoes, which it is expected will be completed October 1, 1890.

It is believed that officers of fair intelligence and industrious habits, although lacking the benefit of a scientific education, can acquire a sufficient knowledge of electricity and high explosives to be useful not only in the torpedo service, but also in its simpler applications to military and civil engineering.

BATTALION OF THE CORPS OF ENGINEERS.

The legal strength of the Battalion of Engineers is five companies, of 150 men each, with a sergeant-major and quartermaster-sergeant, and is officered by details from the commissioned officers of the corps.

The present strength is 19 officers and 459 enlisted men.

The authorized strength of Companies A, B, and C, which are stationed at Willets Point, is 133 men each, and of Company E, stationed at West Point, 100 men.

The total losses from all causes during the year have been 198 and the total gains 253, making a net increase of 55 men.

The battalion has been employed during the year at engineer, ponton, and torpedo drill, infantry drill, rifle practice, photography; and Company E, at West Point, has assisted in the instruction of cadets in military engineering and ponton drill.

A detachment of 2 officers and 29 enlisted men was ordered from Willets Point to Philadelphia, Pa., on August 5, 1889, to report to the governor of Pennsylvania for assignment to duty with the First Brigade of Pennsylvania Guard, for the purpose of giving instruction in aiming drill, target practice, tracing and profiling of field works, reconnaisances, etc. The detachment returned on August 13, 1889.

ENGINEER DEPOT.

A new building to contain engineer models was commenced during the year and is well under way. All materials necessary have been procured, and all work thus far has been done by engineer soldiers. On May 10, 1890, one of the engineer depot store-houses and all combustible contents were destroyed by fire. It was evidently the work of an incendiary. Nothing could be saved except the iron articles. Most of the articles in this building were on hand since the close of the war in 1865. An appropriation of $16,000 for a fire-proof building 40 by 100 feet is recommended to replace this building for storing engineer materials and tools.

Plans and drawings have been made for a small tug-boat, to be used in planting torpedoes, and to replace one worn out in service.

One of the old boarding-houses for the engineer troops has been moved to a suitable place and has been fitted up for storing the ordnance property.

A new electric search-light, "Mangin projector," was procured and set up, and is more effective than either of the old search-lights.

Quite a number of engineer instruments have been purchased, all of the latest pattern. Nearly all the repairs to instruments during the year have been made here; for this purpose the depot repair-shop has been fitted out with a complete set of instrument-maker's appliances.

Torpedo experiments, fish-torpedo trials, tests of explosives, tests of insulated cable, trials with self-acting mines, and tests of various building materials were made during the year.

STATEMENT OF FUNDS.

Congress appropriated for the fiscal year ending June 30, 1890, for engineer depot at Willets Point, N. Y		$19,000.00
Of this there has been expended and pledged	$15,970.37	
Congress appropriated, under act of September 22, 1888, $200,000 for torpedoes for harbor defense; and of this there has been assigned to the commanding officer at Willets Point for disbursement		98,000.00
Of this there has been expended and pledged	73,657.73	
Congress appropriated, under act of March 2, 1889, for torpedoes for harbor defense, and the following was assigned to the commanding officer at Willets Point for disbursement:		
For submarine mines and necessary appliances		250,000.00
For torpedo experiments and instruction of engineer troops in submarine mining		30,000.00
For purchase of movable submarine torpedoes		25,225.00
Of this there has been expended and pledged	167,611.48	
Total appropriated		422,225.00
Total expended and pledged	257,239.58	
Congress appropriated for the fiscal year ending June 30, 1891, for engineer depot at Willets Point, N. Y		9,500.00

There will be required for the fiscal year ending June 30, 1892:

For incidental expenses of depot	$5,000.00
For purchase of materials for instruction of battalion	4,500.00
For purchase and repair of instruments	2,500.00
For purchase and binding of professional works for library	500.00
For a new fire-proof building to store engineer materials	16,000.00
Total	28,500.00

(See Appendix No. 3.)

RIVER AND HARBOR IMPROVEMENTS.

The funds with which the works for the improvement of rivers and harbors were prosecuted during the last fiscal year were derived from the appropriations by the act of August 11, 1888, and such balances of former appropriations as were available. No appropriation for these works was made at the last session of Congress.

A brief statement, derived from the reports of the officers in charge of the several works hereinafter given, sets forth the condition of each improvement, the extent of work performed during the last fiscal year, the amount expended and estimate of amount required for its completion.

Section 2 of the river and harbor act approved March 2, 1867, requires that the Secretary of War shall annually submit to Congress a full estimate for the entire and permanent completion of each river and harbor work, and of the amount that can be profitably expended on each uncompleted work in the next fiscal year.

The river and harbor act approved September 19, 1890, made the funds available for work at a time so late in the season of 1890 that a large part of this appropriation will remain unexpended June 30. 1891; consequently, estimates of amounts that can be profitably expended in the fiscal year ending June 30, 1892, are now submitted only for the works on account of which contracts are to be made for completion as provided for in the act referred to. It is believed that sufficient funds

are provided for the other works by the act approved September 19, 1890, to carry them through the working season of 1891, and are as much as can be profitably expended during the next fiscal year. It is proper, however, to state that each report sets forth the amount necessary to complete the work in question, and provides a basis upon which items of appropriation can if necessary be formulated.

Reports are appended of the work accomplished in the removal of wrecks obstructing or endangering navigation, as provided for in section 4 of the river and harbor act approved June 14, 1880, and enlarged by provision in the river and harbor act of August 2, 1882.

The examinations and surveys provided for by the river and harbor act of August 11, 1888, have been made, and the results thereof reported to Congress from time to time, and such reports as are not contained in the annual report of this office for 1889 will be found in the appendix to this report.

Under the authority given to the Secretary of War in section 12 of the river and harbor act of August 11, 1888, harbor lines have been established at the following localities: Boston, Mass.; Stamford, Conn.; Hudson River, from Troy to New Baltimore, N. Y., New York harbor and adjacent waters, New York and New Jersey; James River, from Richmond to City Point, Va.; Norfolk and Portsmouth harbors, and adjacent waters, Virginia; Fernandina, Fla.; Quincy Bay, Illinois; San Francisco harbor, and adjacent waters, California; and in front of San Diego and Coronado, Cal. The details are given further on in this report.

Examinations were made whenever required by committees of Congress of proposed bills authorizing the construction of bridges upon which the views of the War Department were desired. Of the bills so examined since my last report to the close of the fiscal year, June 30, 1890, 58 originated in the Senate and 78 in the House of Representatives.

Reports upon bills to authorize the construction of bridges across the Mississippi River at New Orleans, will be found in appendix YY, 1 and 2.

Report upon the practicability and necessity of a bridge across the Detroit River at Detroit, Mich., in compliance with a resolution of the Senate Committee on Commerce, and report upon tunneling the river at or near Detroit, Mich., in compliance with a joint resolution of Congress, will be found in Appendix Y Y, 3 and 4.

Examinations were made during the fiscal year of such plans and locations as were submitted by parties interested of bridges proposed to be built over navigable waters, subject to the approval of the Secretary of War, as authorized by acts of Congress. A brief statement is given of the action had in such cases.

Under sections 9 and 10 of the river and harbor act of 1888, persons or corporations owning or controlling bridges over navigable waters of the United States, obstructing the free navigation of said waters, have been notified to so alter the bridges as to render navigation through or under them free, easy, and unobstructed, and in each case a reasonable time was prescribed within which such alteration is to be made. A detailed statement of the cases is given further on in this report.

Reports made in compliance with the requirements of section 2 of the river and harbor act of July 5, 1884, and section 4 of that of August 5, 1886, of instances in which piers, breakwaters, or other works built by the United States in aid of commerce or navigation are used, occupied, or injured by a corporation or an individual, will be found in Appendix Z Z.

The engineering works in the charge of this office are divided into five divisions, and officers of the corps assigned as division engineers to overlook the work, as follows:

West of the Rocky Mountains: Pacific Division, Col. George H. Mendell. East of the Rocky Mountains: Northeast Division, Col. Henry L. Abbot; Southeast Division, Col. William P. Craighill; Southwest Division, Col. Cyrus B. Comstock; and Northwest Division, Col. Orlando M. Poe.

South Pass of the Mississippi River.—During the fiscal year ending June 30, 1890, the channel has been maintained as required by law, except for the first five days in October, 1889, when the central depth between the extreme ends of the jetties was only 29.6 feet instead of the required 30 feet.

Commercial statistics.—Sections 2 of the river and harbor acts of 1866 and 1867 require that the Secretary of War, in reporting upon works of river and harbor improvement, shall state "as far as practicable what amount of commerce and navigation would be benefited by the completion of each particular work."

No provision is made in the above sections for the manner in which the commercial statistics are to be collected, and officers in charge of river and harbor districts in which the improvements are located have to depend upon the courtesy of individuals, boards of trade, representatives of transportation lines, etc., for obtaining the required information. As a consequence, the statistics in many cases are either wanting or incomplete.

The act approved September 26, 1888, makes it "the duty of the Secretary of War to prescribe such rules and regulations in respect to the use and administration of the Des Moines Rapids Canal, the St. Mary's Falls Canal, the Louisville and Portland Canal, and the St. Clair Flats Ship-Canal as in his judgment the public necessity may require," and prescribes certain penalties for violating such rules and regulations.

A paragraph of the rules and regulations for the several canals under this act requires the masters or the clerks of the boats to furnish to one of the officials of the canal such statistics of passengers, cargo, etc., as may be required, and the officers in charge of the canals are thus enabled to furnish the commercial statistics.

It is suggested that similar legislation in respect to collection of commercial statistics in localities where works of river and harbor improvement are carried on would enable the officers in charge to comply more satisfactorily with the requirements of sections 2 of the river and harbor acts of 1866 and 1867.

The following is a draught of a proposed bill for the accomplishment of the desired result:

AN ACT to facilitate the collection of commercial statistics required by sections 2 of the river and harbor appropriation acts of 1866 and 1867:

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That owners, agents, masters, and clerks of vessels arriving at or departing from localities where works of river and harbor improvement are carried on, shall furnish, on application of the persons in local charge of the works, a comprehensive statement of vessels, passengers, freight, and tonnage.

SEC. 2. That every person or persons offending against the provisions of this act shall for each and every offense be liable to a fine of one hundred dollars, or imprisonment not exceeding two months, to be enforced in any district court in the United States within whose territorial jurisdiction such offense may have been committed.

ATLANTIC COAST AND GULF OF MEXICO.

IMPROVEMENT OF RIVERS AND HARBORS IN THE STATES OF MAINE AND NEW HAMPSHIRE.

Officer in charge, Lieut. Col. Jared A. Smith, Corps of Engineers.

1. *Lubec Channel, Maine.*—This channel lies between the eastern extremity of Maine and Campo Bello Island, belonging to the Dominion of Canada.

Originally the channel was but 5 feet in depth at mean low water, and but 2 feet at low water of spring tides.

The project adopted in 1879, and subsequently modified, is for a channel 275 feet wide, 300 feet wide in the bends, and 12 feet deep at mean low water.

Amount expended to June 30, 1889, $149,493.23.

Expended in last fiscal year, $7,719.80.

As a result the channel has been nearly completed as planned. Dredging is now in progress under contract, and the entire width and depth will be obtained with funds available.

While the channel thus made is of great service, yet it is not straight, and the tidal currents are very strong, so that the necessities of commerce in this thoroughfare are not as well served as is desirable.

July 1, 1889, amount available		$1,506.77
July 1, 1889, amount covered by existing contracts		18,000.00
		19,506.77
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$612.70	
July 1, 1890, outstanding liabilities	7,107.10	
July 1, 1890, amount covered by uncompleted contracts made during the fiscal year ending June 30, 1890	10,899.90	
		18,619.70
July 1, 1890, balance available		887.07

(See Appendix A 1.)

2. *Moose-a-bec Bar, Maine.*—The project for this improvement was adopted in 1881, and modified in 1888, the object being to give a direct channel 300 feet wide, and a depth of 14 feet at mean low water over the bar, and to remove ledges near and in the channel to a depth of 16 feet.

The entire amount expended to June 30, 1889, was $32,552.64.

The channel over the bar had been dredged to a width of 200 feet, and a small part of Steam boat Ledge had been removed.

Expenditures in the last fiscal year have been $20,865.04.

As a result the channel over the bar has been widened to 300 feet by dredging on the north side.

This is a great thoroughfare for coasting vessels and steamers, and the improvement thus far has produced wide-reaching benefits.

July 1, 1889, amount available	$1,877.56
July 1, 1889, amount covered by existing contracts	20,488.80
Sept. 30, 1889, amount forfeited on contract Aug. 12, 1887, by failure of contractor	81.00
	22,447.36
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	20,865.04
July 1, 1890, balance available	1,582.32
Amount appropriated by act of September 19, 1890	15,000.00
Amount available for fiscal year ending June 30, 1891	16,582.32

Amount (estimated) required for completion of existing project ..... Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	$80,000.00

(See Appendix A 2.)

3. *Narragaugus River, Maine.*—The obstruction to navigation consisted in a bar from the anchorage near the mouth of the river to deep water, the shoalest part having only 4 feet depth at extreme low water and 5½ feet at mean low water.

The project for improvement consists in dredging the channel to a depth of 11 feet as far as the lowest landing, and thence 9 feet deep to the anchorage.

The amount expended to June 30, 1889, was $10,259.58.

Expenditures in last fiscal year were $9,740.42.

As a result, the lower part of the channel has been dredged to grade 55 feet wide a distance of 2,800 feet, thence 100 feet wide a distance of 1,600 feet, then a width of 300 feet to form a turning basin about 600 feet long. This permits the steamers to land at the lower wharves at all stages of tide, but requires great care to keep in the narrow channel.

July 1, 1889, amount available	$740.42
July 1, 1889, amount covered by existing contracts	9,000.00
	9,740.42
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	9,740.42
Amount appropriated by act of September 19, 1890	7,500.00
Amount (estimated) required for completion of existing project ..... Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	22,500.00

(See Appendix A 3.)

4. *Breakwater from Mount Desert to Porcupine Island, Maine.*—The anchorage and landing at Bar Harbor is entirely exposed to storms and seas setting in from southerly directions.

Under requirements of the river and harbor act of August 5, 1886, a plan and estimate for a breakwater from Mount Desert to Porcupine Island was submitted by the engineer officer in charge. (Page 483, Report of Chief of Engineers, 1887.)

The river and harbor act of August 11, 1888, appropriated $50,000 for commencing the work.

A contract was therefore made with the lowest bidder, Mr. Fred L. Andrews of Biddeford, Me., for delivering stone in the breakwater.

Previous to June 30, 1889, an expenditure of $992.84 had been incurred for necessary contingencies. Delivery of stone was commenced July 1, and was continued in a very unsatisfactory manner until November 5, 1889.

On the 7th of November it was ascertained that the contractor, after receiving his monthly payment, had left the work and vicinity, and that many accounts due from him to various persons for labor, freight, and stone remained unpaid.

No further work has been done or attempted by the contractor, nor have the accounts mentioned been paid.

The limit of time in which work under the contract should be completed expired June 30, 1890. The contractor has therefore forfeited all rights under the contract, and has made himself and bondsmen liable to forfeiture of amount of the bond.

Amount of stone for which payments have been made is 11,126 tons.

Amount delivered for which no payments have been made, 267 tons.

It is proposed to expend the present balance in continuing the construction of the breakwater.

July 1, 1889, amount available	$4,007.16
July 1, 1889, amount covered by existing contracts	45,000.00
	49,007.16
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	12,718.94
July 1, 1890, balance available	36,288.22
Amount appropriated by act of September 19, 1890	50,000.00
Amount available for fiscal year ending June 30, 1891	86,288.22
Amount (estimated) required for completion of existing project Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	700,000.00

(See Appendix A 4.)

5. *Bagaduce River, Maine.*—The river and harbor act of August 5, 1886, required an examination or survey of the Bagaduce River, Maine.

A report, with estimate of cost of works considered necessary, was submitted by the engineer officer in charge, February 2, 1888. (See Report of Chief of Engineers for 1888, page 401.)

The project adopted for the improvement consists of deepening the channel to give a width of 100 feet and a low-water depth of 6 feet from South Penobscot to Bridge's Point. This includes dredging and removing rocks. The project also includes removing a small amount of rock in Johnson's Narrows.

By act of August 11, 1888, Congress appropriated $3,000 for the improvement. As this small sum could not be judiciously expended in a way to accomplish any beneficial result, work on the improvement has been suspended to await the further action of Congress.

Previous to June 30, 1889, an expenditure of $100 from the appropriation was incurred in the necessary office work, preparing plans, estimates, etc.

To effect any valuable improvement of the channel all the rock must be first removed; but little result can come from the removal of a portion only.

July 1, 1889, amount available	$2,900.00
July 1, 1890, balance available	2,900.00
Amount appropriated by act of September 19, 1890	4,000.00
Amount available for fiscal year ending June 30, 1891	6,900.00
Amount (estimated) required for completion of existing project Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	39,875.00

(See Appendix A 5.)

6. *Penobscot River, Maine.*—The appropriation for this improvement is divided into two parts by allotment: First, Bangor to Crosby's Narrows; and, second, between Bucksport and Winterport.

Above Crosby's Narrows the former channel was too narrow to afford room to the numerous vessels and rafts, and between Bucksport and Winterport the channel was crooked and insufficiently deep.

The projects of improvement consist in widening the channel at Bangor and Crosby's Narrows by dredging and deepening the channel below by dredging and contraction works.

Estimated cost of both projects, $440,000.

Amount expended to June 30, 1889:

Above Crosby's Narrows	$34,939.83
Below Winterport	821.73
Total	35,761.56

Expended in last fiscal year:

Above Crosby's Narrows	$487.04
Below Winterport	26,355.54
Total	26,842.58

As a result the widening of the channel at Bangor has been completed and the channel below Winterport has been dredged to a depth of 22 feet at low water throughout nearly the entire width.

Should the dredged channel prove permanent the expense of contraction works included in estimate will be avoided.

Dredging below Winterport under contract will be completed in July.

Dredging on the shoals above Crosby's Narrows is in progress and will probably be completed this season.

July 1, 1889, amount available		$31,238.44
July 1, 1889, amount covered by existing contracts		18,000.00
		49,238.44
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$21,994.57	
July 1, 1890, outstanding liabilities	4,848.01	
July 1, 1890, amount covered by uncompleted contracts made during the fiscal year ending June 30, 1890	20,713.96	
		47,556.54
July 1, 1890, balance available		1,681.90
Amount appropriated by act of September 19, 1890		25,000.00
Amount available for fiscal year ending June 30, 1891		26,681.90
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		330,000.00

(See Appendix A 6.)

7. *Belfast Harbor, Maine.*—A project to deepen the water so that vessels drawing 10 to 12 feet could reach the wharves on the west side was adopted in 1876.

The work was completed in 1880, leaving a small balance of funds available.

Under requirements of the river and harbor act of August 11, 1888, an examination and survey of the harbor have been made. The reports of the officer charged with the work have been submitted and printed in House Ex. Doc. No. 81, Fifty-first Congress, first session. (See Appendix A 22.)

The expenditures of the last fiscal year have been $800.17.

The project of improvement submitted consists in dredging a part of the main channel to give a depth of 15 feet, and to deepen portions of the east and west sides to 8 and 13 feet respectively at mean low water. The estimated cost is $52,000.

July 1, 1889, amount available	$2,786.16
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	800.17
July 1, 1890, balance available	1,985.99
Amount appropriated by act of September 19, 1890	10,000.00
Amount available for fiscal year ending June 30, 1891	11,985.99

Amount (estimated) required for completion of existing project..... Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	$42,000.00

(See Appendix A 7.)

8. *Camden Harbor, Maine.*—This harbor is situated on the west side of Penobscot Bay. The harbor proper was so shallow that at low water vessels drawing more than 6 feet could not reach the wharves.

The project for improvement consists in deepening the harbor to 10 feet, and the approaches to a depth of 12 feet at mean low water.

At the date of last report the improvement had not been commenced but a contract had been made for dredging.

Work was commenced August 26 and completed October 3 as far as could be done with available funds.

The expenditures for the last fiscal year have been $4,873.81.

As a result the channel on the west side has been deepened to 10 feet at mean low water 75 feet wide for a distance of 1,150 feet, and 50 feet wide an additional distance of 905 feet.

This will permit much larger vessels to reach the wharves adjacent to the improved channel.

July 1, 1889, amount available	$405.14
July 1, 1889, amount covered by existing contracts	4,500.00
	4,905.14
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	4,873.81
July 1, 1890, balance available	31.33
Amount appropriated by act of September 19, 1890	6,000.00
Amount available for fiscal year ending June 30, 1891	6,031.33
Amount (estimated) required for completion of existing project..... Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	49,000.00

(See Appendix A 8.)

9. *Rockport Harbor, Maine.*—This harbor is on the west side of Penobscot Bay, about 6½ miles above Rockland.

The upper portion of the harbor was shallow, so that the wharves could not be reached at low stages of tides.

The project for improvement consists in dredging the upper part to a depth of 12 feet at mean low water.

The total estimated cost was $14,000, on the presumption that so small an amount would be appropriated in a single sum.

Previous to June 30, 1889, no work had been commenced, but the small amount of $178.68 had been expended in preparatory work.

Dredging under the contract which was reported last year was completed in December. This has resulted in deepening to grade a little more than two-thirds of the area included in project.

Amount expended in year ending June 30, 1890, $9,808.13.

July 1, 1889, amount available	$821.32
July 1, 1889, amount covered by existing contracts	9,000.00
	9,821.32
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	9,808.13
July 1, 1890, balance available	13.19
Amount appropriated by act of September 19, 1890	5,000.00
Amount available for fiscal year ending June 30, 1891	5,013.19

(See Appendix A 9.)

10. *Rockland Harbor, Maine.*—Originally this harbor was open to all easterly winds and seas, so that at such times the anchorage was unsafe and the seas often broke over the wharves.

The project for improvement adopted in 1881 and modified in 1890 consists in the construction of a breakwater to protect the anchorage and form a harbor of refuge.

The entire estimated expense of the project as modified is $712,500.

Expenditures to June 30, 1889, were $134,337.67.

Expenditures in last fiscal year were $18,162.33.

As a result the breakwater has been extended to the full distance of 1,900 feet originally designed; 1,235 feet of this length has been raised to high-water level with a width of 20 feet on top. The remaining part next the shore is 12 feet wide on top and 5 feet above mean low water. This is considered sufficient.

Parties interested in the navigation and use of the harbor as a refuge have for some years urged the necessity of extending the present breakwater rather than to construct a second one detached as in the original plan.

On the recommendation of the officer in charge the question has been submitted to The Board of Engineers, and the recommendation to extend the present breakwater has been approved by the Board and by the Secretary of War.

The plan as modified will afford largely increased room for anchorage for the numerous vessels which need the harbor as a refuge.

July 1, 1889, amount available	$2,190.82
July 1, 1889, amount covered by existing contracts	15,971.51
	18,162.33
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	18,162.33
Amount appropriated by act of September 19, 1890	37,500.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	442,500.00

(See Appendix A 10.)

11. *Kennebec River, Maine.*—The navigation of the river is much obstructed by ledges of rock and by shoals.

The project for improving the river consists in removing the shoals by contraction works and by dredging, and removing the ledges by blasting.

The estimated expense of the entire improvement is $410,500.

Amount appropriated August 11, 1888, $75,000.

Amount expended to June 30, 1889, $6,186.54.

This expenditure was on the contraction works at Hatch's Rock Shoal near Richmond, and was not sufficient to produce any deepening of the channel.

Amount expended in last fiscal year, $50,652.11.

As a result the contraction works at Hatch's Rock have been practically completed, and a deepening of about 1 foot in the channel has already resulted, so that the steamers running from Gardiner to Boston have passed the shoal at low water without difficulty.

The contraction works at Beef Rock Shoal are well advanced, but no definite results of deeper water are yet obtained.

The completion of the project will be a great benefit to the large commerce of the river.

July 1, 1889, amount available		$3,638.40
July 1, 1889, amount covered by existing contracts		65,175.06
		68,813.46
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$40,436.67	
July 1, 1890, outstanding liabilities	10,215.44	
July 1, 1890, amount covered by uncompleted contracts made during the fiscal year ending June 30, 1890	17,082.39	
		67,734.50
July 1, 1890, balance available		1,078.96
Amount appropriated by act of September 19, 1890		50,000.00
Amount available for fiscal year ending June 30, 1891		51,078.96
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		285,500.00

(See Appendix A 11.)

12. *Harbor at Portland, Maine.*—Before the adoption of the present project for improvement there was but 21 feet of water to the wharves used by trans-atlantic steamers, and in the upper part of the harbor the depth at wharves in places did not exceed 12 feet.

The project for improvement consists in dredging a channel 500 feet wide and 29 feet deep at mean low water to the lower wharves and to deepen the channel to 16 feet in front of upper wharves. The latter part of project was not included in last annual report and estimate.

Previous to June 30, 1889, there had been expended the sum of $67,245.63.

This has resulted in a channel 1,600 feet long and 400 feet wide along the wharf front, connected with deep water by a channel 2,800 feet long and 227 feet wide, all to a depth of 29 feet.

The heaviest laden steamers can now reach the wharves at the lowest stages of the tide, but a greater width is needed for entire safety.

The expenditures of the last fiscal year have been for contingent office work.

July 1, 1889, amount available	$2,754.37
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,062.60
July 1, 1890, balance available	1,691.77
Amount appropriated by act of September 19, 1890	40,000.00
Amount available for fiscal year ending June 30, 1891	41,691.77
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	30,000.00

(See Appendix A 12.)

13. *Channel in Back Cove, Portland, Maine.*—Originally this channel was only navigable at high stages of water. A low-water depth of 8 to 10 feet extended over about half its length and parts of the remainder had a low-water depth not exceeding 1 foot.

The project for improvement adopted in 1886 consists in widening and deepening the channel to give a low-water depth of 12 feet and a width of 300 feet on the bottom for a distance of about 5,600 feet following the harbor commissioners' line.

Amount expended to June 30, 1889, was $33,062.10.

Amount expended in last fiscal year, $17,912.30.

As a result the 12-foot channel has been extended a total length of 4,050 feet; the entire length has been widened to 90 feet on the bottom, and a winding basin has been dredged 400 feet wide.

Work under contract last reported was completed October 11, 1889.

The practicable channel thus far made has resulted in bringing many vessels to the upper wharves, and in greatly increased facilities for business.

The amount available is to be expended in widening and extending the channel.

July 1, 1889, amount available	$1,843.94
July 1, 1889, amount covered by existing contracts	16,343.96
	18,187.90
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	17,912.30
July 1, 1890, balance available	275.60
Amount appropriated by act of September 19, 1890	25,000.00
Amount available for fiscal year ending June 30, 1891	25,275.60
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	103,750.00

(See Appendix A 13.)

14. *Breakwater at mouth of Saco River, Maine.*—This breakwater was partially built in 1869 to 1873. In 1883 it was found necessary to complete the breakwater to the full height of 15 feet and top width of 12 feet, to secure the object of preventing the sand from drifting into the channel and maintaining a bar at the mouth of the Saco River.

There had been expended to June 30, 1889, the sum of $27,856.14.

Expended in last fiscal year, $10,125.87.

As a result the breakwater has been completed from its outer end, a distance of 2,100 feet, and partially repaired about 200 feet further.

The breakwater holds the channel on one side only, and breaks the seas, but the repairs have not increased the depth of water in the channel.

To obtain deeper water, a jetty is required opposite the channel, as mentioned in report for Saco River improvement.

The completion of the repairs will add to the stability of the breakwater and to the protection of the channel.

July 1, 1889, amount available		$982.86
July 1, 1889, amount covered by existing contracts		11,161.00
		12,143.86
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$7,280.10	
July 1, 1890, outstanding liabilities	2,845.77	
July 1, 1890, amount covered by uncompleted contracts made during the fiscal year ending June 30, 1890	4,700.00	
		11,825.87
July 1, 1890, balance available		317.99
Amount appropriated by act of September 19, 1890		(*)

(See Appendix A 14.)

* The amount appropriated for this work in act of September 19, 1890, is included in the appropriation for Saco River. See report on Saco River, page 23.

15. *Saco River, Maine.*—The channel was obstructed by a bar at the mouth, by shoals, and in one place by a ledge, and did not afford a continuous depth exceeding 3½ feet at mean low water, though much of the channel is very much deeper.

The project for improvement includes the works considered necessary to secure and maintain a channel having not less than 6 feet depth at mean low water to the head of tide-water at Saco and Biddeford.

Expended to June 30, 1889, $17,513.43.

Expended in last fiscal year, $3,465.56.

As a result the ledge at Little Islands has been removed to the depth required. A long jetty and training-wall has been constructed above the Little Islands, and part of the wing-dam and wall at Cow Island has been built.

The channel is improved in places but no greater draught of vessels can be used until the bar is removed at the mouth of the river.

Work under the contract reported last year has not been completed and the limit of time has been extended to September 1, 1890.

The jetty at the bar is the most important work and it should be completed.

July 1, 1889, amount available		$302.70
July 1, 1889, amount covered by existing contracts		4,683.87
		4,986.57
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$3,064.73	
July 1, 1890, outstanding liabilities	400.83	
July 1, 1890, amount covered by uncompleted contracts made during the fiscal year ending June 30, 1890	1,521.01	
		4,986.57
Amount appropriated by act of September 19, 1890*		65,000.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		97,500.00

(See Appendix A 15.)

16. *Kennebunk River, Maine.*—During the last fiscal year some small expenses have been incurred in making a chart of the river and obtaining deeds to lands belonging to the United States.

Total expenditure in year $76.62.

Under requirements of the river and harbor act of August 11, 1888, an examination of the river was made in December, 1888, and in the summer of 1889 the old piers and grounds were surveyed.

The reports were printed in House Ex. Doc. No. 136, Fifty-first Congress, first session. (See Appendix A 26.)

The amount estimated to repair the piers and construct one small jetty is $20,000.

July 1, 1889, amount available	$76.62
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	76.62
Amount appropriated by act of September 19, 1890	20,000.00

(See Appendix A 16.)

17. *York Harbor, Maine.*—The project for this improvement, adopted in 1886, has for its object the widening of the channel in three bends where the low-water depth of 10 feet did not exceed 75 feet wide, and where the tidal currents are very rapid.

* Including *breakwater at the mouth of* Saco River.

Part of the material to be removed is a ledge of rock and the remainder is a hard sandy material, united with small bowlders, which can be dredged.

Expenditures to June 30, 1889, $13,221.83.

Expended in last fiscal year, $3,307.07.

Various causes have operated to delay the contractor upon this work, which will, however, doubtless be completed the present season, as far as available funds may permit.

The material removed in last year has been 1,210.1 cubic yards sand and bowlders and 214.7 cubic yards of ledge.

The completion of the improvement will add to convenience and safety of entering and leaving the harbor.

July 1, 1889, amount available		$978.17
July 1, 1889, amount covered by existing contracts		10,800.00
		11,778.17
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$1,050.47	
July 1, 1890, outstanding liabilities	2,256.60	
July 1, 1890, amount covered by uncompleted contracts made during the fiscal year ending June 30, 1890	7,965.45	
		11,272.52
July 1, 1890, balance available		505.65
Amount appropriated by act of September 19, 1890		10,000.00
Amount available for fiscal year ending June 30, 1891		10,505.65
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		9,000.00

(See Appendix A 17.)

18. *Harbor at Portsmouth, New Hampshire.*—The project for improving this harbor was adopted in 1879, the object being to check the strong tidal currents in the harbor, and to give a navigable depth over the ledge known as Gangway Rock, opposite the navy-yard.

Expenditures to June 30, 1889, $107,679.14.

Expended in last fiscal year, $2,391.46.

The results are the entire completion of the project, save a part of the ledge on the point of Badger's Island.

The work under contract heretofore reported for removing Badger's Point ledge is not yet completed. The balance of available funds is sufficient to complete all that is contemplated.

July 1, 1889, amount available		$809.80
July 1, 1889, amount covered by existing contracts		13,511.06
		14,320.86
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$2,206.66	
July 1, 1890, outstanding liabilities	184.80	
July 1, 1890, amount covered by uncompleted contracts made during the fiscal year ending June 30, 1890	11,637.96	
		14,029.42
July 1, 1890, balance available		291.44
Amount appropriated by act of September 19, 1890		13,000.00
Amount available for fiscal year ending June 30, 1891		13,291.44

(See Appendix A 18.)

19. *Bellamy River, New Hampshire.*—This river is a tidal branch of Great Bay, which connects with the Piscataqua River, 4 miles above the bridge at Portsmouth.

The upper part was originally too shallow for navigation with any vessels of greater draught than flat-boats.

The improvement consists in dredging the shallow part of channel to give a mean low-water depth of 5 feet, or about 11¾ feet at high water, which will permit vessels of about 500 tons to ascend to head of tide-water.

Amount expended to June 30, 1889, was $5,205.33.

Dredging under first contract was commenced May 1, 1889, and was completed August 31, 1889.

As a result the channel has been dredged to full width and depth a distance of 4,950 feet. Large vessels can now go nearly 3 miles up the river.

The distance remaining to be improved is about 1½ miles.

Estimate of funds submitted is for completion of project as explained.

July 1, 1889, amount available	$277.92
July 1, 1889, amount covered by existing contracts	4,516.75
	4,794.67
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	4,794.67
Amount appropriated by act of September 19, 1890	10,000.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	8,000.00

(See Appendix A 19.)

20. *Cocheco River, New Hampshire.*—This river may be considered as the headwater of the Piscataqua River.

It was originally so much obstructed by a ledge of rock, bowlders, etc., as to permit no navigation of a general character.

The project which was completed in 1889 gave a channel having a mean low-water depth of 5 feet, and a width in the narrowest place of 40 feet on the bottom to the city of Dover.

Under provisions of section 13 of the river and harbor act of August 11, 1888, a survey of the river has been made from Dover to the confluence with the Salmon Falls River, where the two form the Piscataqua.

The officer in charge of the survey has submitted a project for improving the river by deepening the channel to 7 feet at mean low water and giving a minimum width of 50 feet. The full report is given in House Ex. Doc. No. 74, Fifty-first Congress, first session. (See Appendix A 27.)

July 1, 1889, amount available	$290.28
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	290.28
Amount appropriated by act of September 19, 1890	25,000.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	150,000.00

(See Appendix A 20.)

21. *Harbor of refuge at Little Harbor, New Hampshire.*—This is a small harbor at the mouth of the Piscataqua River. It is the broad

mouth of a small channel of the river itself. There is room for a considerable anchorage, but the water is too shallow save for small vessels. The ebb tides from the main channel are so rapid that in strong northerly winds it is impossible for sailing vessels to reach an anchorage in the river.

The object of the improvement is to form a refuge for coasters and fishing vessels in northeasterly storms when they can not get into Portsmouth Harbor.

The amount expended upon the improvement to June 30, 1889, was $21,325.99.

Amount expended in last fiscal year, $8,674.01.

As a result the channel over the bar has been deepened to 9 feet at mean low water, 100 feet wide, and the anchorage has been widened to 300 feet.

This affords room for some small vessels, but is too limited in depth and extent for a general refuge.

It is proposed to expend the available funds for continuing this improvement, first, in constructing the small breakwaters at the entrance to the harbor, and then in widening and deepening the channel and anchorage.

July 1, 1889, amount available	$1,168.13
July 1, 1889, amount covered by exising contracts	7,505.88
	8,674.01
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	8,674.01
Amount appropriated by act of September 19, 1890	40,000.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	165,000.00

(See Appendix A 21.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENT, TO COMPLY WITH REQUIREMENTS OF RIVER AND HARBOR ACT OF AUGUST 11, 1888.

It appearing from the preliminary examination made by the local engineer that the following localities are worthy of improvement, and the public necessity therefor being apparent from the facts and reasons reported, which are concurred in by the Chief of Engineers, Lieutenant-Colonel Smith was charged with and completed their survey, the results of which were transmitted to Congress and printed in Ex. Doc's of the Fifty-first Congress, first session.

1. *Belfast Harbor, Maine.*—Printed as House Ex. Doc. 81. (See also Appendix A 22.)

2. *Union River, and Union River Bay, Maine.*—Printed as House Ex. Doc. 138. (See also Appendix A 23.)

3. *St. Croix River, Maine.*—Printed as House Ex. Doc. 89. (See also Appendix A 24.)

4. *Pleasant River from Columbia Falls to its mouth, Maine.*—Printed as House Ex. Doc. 208. (See also Appendix A 25.)

5. *Kennebunk River, Maine.*—Printed as House Ex. Doc. 136. (See also Appendix A 26.)

6. *Cocheco River, New Hampshire, from Dover to its mouth.*—Printed as House Ex. Doc. 74. (See also Appendix A 27.)

IMPROVEMENT OF RIVERS AND HARBORS IN MASSACHUSETTS.

Officer in charge, Lieut. Col. S. M. Mansfield, Corps of Engineers.

1. *Newburyport Harbor, Massachusetts.*—The object of the improvement is to create a channel through the outer bar 1,000 feet wide, and with a least depth of 17 feet at mean low water, or 24½ feet at mean high water.

The project adopted in 1880 and modified in 1883 is to build two converging rubble-stone jetties, so located as to give a proper direction to the current, and thereby produce and maintain the desired result. The estimated cost of the project was $375,000.

The original depth of water on the bar was 7 feet at mean low water.

To June 30, 1889, $211,444.95 had been expended, and the north jetty was 2,675 feet long, of which 2,080 feet were fully completed and 595 feet was a core of stone built up to low water. The south jetty was 1,300 feet long, of which 1,077 feet were fully completed and 223 feet built up to low water.

The Plum Island Dike was 817 feet long, 5½ feet high above mean low water, except near the center, where a weir is left temporarily 150 feet long and 2 feet above mean low water.

The sand-catch in rear of the south jetty was in two branches, one 480 feet long and one 572 feet.

All these works were in good order.

During the fiscal year 4,814 tons of stone were deposited in the north jetty at an expense of $9,484.58. It is now 2,200 feet long, fully completed, and 475 feet additional length has been partly completed.

On June 30, 1890, the south jetty, the Plum Island Dike, and the sand-catch remain in the same condition as at the date of the last report.

A survey of the bar was made in May and June, 1890. It showed that the channel had improved in width and depth during the year.

The advantages to be derived from the completion of the project are the deepening and widening of the channel across the bar, thereby affording a harbor of refuge on the inside of Salisbury Beach, and also affording easy access at high water to the wharves at Newburyport for vessels drawing 17 feet, approximately.

July 1, 1889, amount available	$3,722.39
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	2,323.64
July 1, 1890, balance available	1,398.75
Amount appropriated by act of September 19, 1890	25,000.00
Amount available for fiscal year ending June 30, 1891	26,398.75
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	117,500.00

(See Appendix B 1.)

2. *Merrimac River, Massachusetts.*—The object of the improvement is to straighten, deepen, and widen the natural channel of the river from its mouth to the Upper Falls, a distance of 21½ miles.

The channel originally was narrow, crooked, and much obstructed by ledges, bowlders, and shoals; and below Newburyport by ledges, cribs, piers, and wrecks.

At mean low water vessels drawing not to exceed 7 feet could cross the bar and proceed about 6 miles above Newburyport.

The mean rise or fall of the tide at the mouth of the river is 7½ feet, at Haverhill Bridge, 4 feet.

The project originally adopted in 1870, proposed to remove obstructions from the Upper and Lower Falls, to remove Gangway Rock, to remove the wreck of the schooner *Globe*, and to remove the "Boilers." The cost was estimated at $69,025.

This project was revised and extended in 1874 to include the removal of rocks at Deer Island and Rock Bridges, and at Little Curriers Shoal, so that the channel should have the following depths at ordinary high-water stages of the river: From the mouth to Deer Island Bridge (5 miles), 16½ feet; from Deer Island Bridge to Haverhill Bridge (12½ miles), 12 feet; thence to the foot of Mitchell's Falls (1½ miles), 10 feet; through Mitchell's Falls to the head of the Upper Falls (2½ miles), not less than 4½ feet, with the mill water at Lawrence running. This revised project was estimated to cost $147,000.

The total expenditures to June 30, 1889, were $170,500, and the river channel had been improved in accordance with the modified project, with the exception of the removal of the "Boilers," upon which no work has been done.

No operations were in progress during the year, and the improvement remains in good order.

To complete the improvement so that the same depth of water which has been obtained through Mitchell's Falls can be carried to Lawrence, additional work will be required at the falls above Haverhill, which is estimated to cost $11,000; and additional improvements could be made in the lower part of the river, which are estimated to cost $11,500, or a total of $22,500.

The improved channel is in good order.

Amount appropriated by act of September 19, 1890	$10,000.00
Amount (estimated) required for completion of existing project ..... Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	1,500.00

(See Appendix B 2.)

3. *Powow River, Massachusetts.*—Powow River is a tributary of the Merrimac River, into which it enters from the north, about 3½ miles above Newburyport.

From the mouth, tide-water extends 9,600 feet in a narrow, crooked channel, not navigable at low water.

The project proposed for its improvement is to dredge a channel 9,600 feet long, 60 feet wide, and 12 feet deep at mean high water, at an estimated cost of $77,000.

The river and harbor act of August 11, 1888, appropriated $3,000 for this work, provided a suitable draw was built in the bridge which now crosses the mouth of the river.

Action is in progress by the town authorities, having in view compliance with this proviso.

No expenditures were made during the year ending June 30, 1890, and the original condition of the river is unaltered.

July 1, 1889, amount available	$3,000.00
July 1, 1890, balance available	3,000.00
Amount appropriated by act of September 19, 1890	5,000.00
Amount available for fiscal year ending June 30, 1891	8,000.00
Amount (estimated) required for completion of existing project ..... Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	69,000.00

(See Appendix B 3.)

4. *Ipswich River, Massachusetts.*—Ipswich River empties into Plum Island Sound about 9 miles south of Newburyport, Mass. It is navigable from its mouth to the wharves at Ipswich, a distance of 3 miles. Before improvement, at low water not to exceed 1½ feet draught could be carried in a narrow channel.

The mean rise or fall of the tide is 8.4 feet.

The object of the improvement is to widen and deepen the natural channel of the river.

The original project was submitted in 1875. It proposed a channel 60 feet wide and 4 feet deep at mean low water, at an estimated cost of $25,000.

The total amount appropriated for this improvement to date is $5,000.

The amount expended to June 30, 1889, was $2,532.08. At that date a navigable channel existed at least 40 feet wide and 4 feet deep at mean low water.

No expenditures were made during the fiscal year.

Sealed proposals were invited by circular letter dated September 27, 1889, for the completion of the present partial project. No bids were received in response.

On April 10, 1890, bids were again invited by circular letter, and two proposals were received. Both were rejected as the lowest would make the improvement cost at least twice the amount available, and no advantage to commerce would result from its partial completion.

The work of completing this improvement, as now proposed, has been publicly advertised three times and it is evident that the small amount of work to be done in this locality, so difficult of access, will cost more than similar work in more accessible places.

The condition of the improvement June 30, 1890, is the same as on June 30, 1889.

The prospective benefits to commerce are increased facilities and safety to navigation.

July 1, 1889, amount available	$2,467.92
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	5.00
July 1, 1890, balance available	2,462.92
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	20,000.00

(See Appendix B 4.)

5. *Harbor of Refuge, Sandy Bay, Cape Ann, Massachusetts.*—This bay is situated at the northeastern extremity of Cape Ann, Massachusetts. It is open to the full effect of easterly and northeasterly gales.

The proposed improvement contemplates the construction of a national harbor of refuge of the first class. The anchorage covered by the proposed breakwater will contain 1,377 acres.

The estimated cost of the improvement is $5,000,000.

The expenditures to June 30, 1889, were $222,865.26.

The condition of the improvement on June 30, 1889, was as follows:

Two hundred and eighty-four thousand eight hundred and ninety-nine tons of rubble-stone had been deposited, by which 2,400 feet of the substructure of the breakwater had been essentially completed.

Operations were in progress under a contract to deposit 110,000 tons of rubble-stone. During the fiscal year 68,035 tons were deposited under the existing contract, and it was satisfactorily completed June

30, 1890, after a total of 110,000 tons had been deposited in the breakwater, the substructure of which is at the date of this report essentially completed between cross-ranges 140 and 3,540.

The prospective benefits to commerce and navigation by the construction of this harbor of refuge are increased safety to life and property, and a consequent reduction in freights and insurance.

July 1, 1889, amount available		$19,933.37
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$7,657.26	
July 1, 1890, outstanding liabilities	41.67	
		7,698.93
July 1, 1890, balance available		12,234.44
Amount appropriated by act of September 19, 1890		150,000.00
Amount available for fiscal year ending June 30, 1891		162,234.44
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		4,550,000.00

(See Appendix B 5.)

6. *Gloucester Harbor, Massachusetts.*—Gloucester Harbor is an important center for the fishing fleet of New England, about 20 miles north of Boston. Its inner harbor was originally obstructed by sunken rocks and shoals, preventing free movement of vessels, and the approaches to the wharves were shallow, varying from 1 to 12 feet. The outer harbor was open to all southerly winds.

The first project submitted in compliance with the act of July 11, 1870, proposed to clear the harbor of sunken rocks and to build a stone breakwater from Eastern Point to Round Rock Shoal. The operations in execution of this general project, under the acts of July 11, 1870, and June 10, 1872, have been confined solely to the removal of isolated sunken rocks specially obstructive to the navigation of the inner harbor.

The act of June 10, 1872, appropriated $10,000, which sum was applied to the removal of Clam Rock, Pinnacle Rock, rock off J. Friend's Wharf, rock off Pew's Wharf, and a portion of Babson's Ledge.

The act of August 5, 1886, appropriated $5,000 for a survey of the harbor and for continuing work on Babson's Ledge.

The survey was completed in December, 1886, and a report and general project based on this survey was published in the Report of the Chief of Engineers for 1887, page 500.

The revised project proposed to remove from the inner harbor 101½ cubic yards of rock known to exist, and 216,000 cubic yards, scow measurement, of material, at an estimated cost of $65,000; and to construct the breakwater that extends from Eastern Point to Round Rock Shoal, recommended in the project of 1884, at an estimated cost of $752,000.

The amount expended to June 30, 1889, was $24,566.46, inclusive of outstanding liabilities.

On June 30, 1889, the condition of the improvement was as follows:

Clam Rock, Pinnacle Rock, rock off J. Friend's Wharf, and rock off Pew's Wharf had been reduced to the level of the surrounding bottom, and Babson's Ledge to 14 feet at mean low water. Two channels of approach to the wharves in Harbor Cove had been dredged; each was 40 feet wide and 10 feet deep at mean low water; the eastern one was 550 feet long, the western 1,000 feet long.

No operations were in progress during the fiscal year.

The condition of the improvement June 30, 1890, is the same as on June 30, 1889.

July 1, 1889, amount available	$433.54
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	14.38
July 1, 1890, balance available	419.16
Amount appropriated by act of September 19, 1890	15,000.00
Amount available for fiscal year ending June 30, 1891	15,419.16
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	792,000.00

(See Appendix B 6.)

7. *Manchester Harbor, Massachusetts.*—Manchester Harbor is situated about 5½ miles northeast from the entrance of Salem Harbor, Massachusetts.

Its outer roadstead contains 300 acres approximately, with 5 fathoms of water. Its entrance channel is 100 feet wide and 6½ feet deep at mean low water up to Proctor's Point; it then shoals rapidly to a depth of 1½ feet at the "Narrows," 1,400 feet from Proctor's Point, and for a further distance of 2,500 feet to the town wharves no low-water channel exists.

The project for its improvement is based on the survey provided for in the act of August 5, 1886. It proposes to dredge a channel from Proctor's Point to the town wharves 4,000 feet long, 60 feet wide, and 4 feet deep at mean low water, at an estimated cost of $14,300.

The act of August 11, 1888, appropriated $2,500 for this work. It was proposed to expend this amount in partial execution of the project in the removal of a ledge near Proctor's Point, but after proposals had been advertised for and opened November 2, 1888, it was decided to retain the amount available in the Treasury until further funds were provided.

July 1, 1889, amount available	$2,396.93
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	6.00
July 1, 1890, balance available	2,390.93
Amount appropriated by act of September 19, 1890	5,000.00
Amount available for fiscal year ending June 30, 1891	7,390.93
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	6,800.00

(See Appendix B 7.)

8. *Lynn Harbor, Massachusetts.*—The object of this improvement is to obtain a more direct, wider, and deeper channel of approach to the city wharves. The original channels were narrow and crooked and had but 6 feet depth at mean low water, and the greater part of the harbor was bare at low water.

The project was adopted in 1884. It proposed a channel 200 feet wide and 10 feet deep at mean low water through the outer and inner bars. The outer channel is 3,610 feet long; the inner one 6,450 feet. It is supposed that the inner channel will need occasional dredging. To aid in keeping the outer channel open a training-wall is proposed, if experience shall show it to be necessary.

On September 24, 1888, it was proposed to extend the inner channel

400 feet within the harbor line, and to excavate at its inner end an anchorage basin 500 by 300 feet in area, 10 feet deep at mean low water, at an estimated cost of $25,000.

The cost of the original project was estimated to be $157,000.

The total expenditures to June 30, 1889, were $66,015.92, of which $66,000 had been expended on the original project.

The condition of the improvement on June 30, 1889, was as follows:

The outer channel had been completed; the inner channel was of full length and depth, but only 150 feet wide. A contract was in force to dredge 28,000 cubic yards of material.

The appropriation of 1888 could be expended at the discretion of the Secretary of War in continuing the improvement, or part in the western channel or in the anchorage basin. A survey made early in the fiscal year showed that no part of the balance on hand could be expended to advantage in the western channel, and the funds available were expended under the existing contract in dredging from the anchorage basin 25,571 cubic yards at a cost of $9,399.40.

The condition of the improvement on June 30, 1890, is as follows:

The outer channel is 3,610 feet long, 200 feet wide, 10 feet deep at mean low water; the inner channel is 6,450 feet long, 150 feet wide, 10 feet deep; the anchorage basin is 125 feet wide, 500 feet long, 10 feet deep, connected with the inner channel by a cut 400 feet long, 100 feet wide, 10 feet deep. Nothing has been done on the training-wall.

The prospective benefits to commerce are increased facilities and safety to navigation.

July 1, 1889, amount available	$1,635.58
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,050.90
July 1, 1890, balance available	584.68
Amount appropriated by act of September 19, 1890	15,000.00
Amount available for fiscal year ending June 30, 1891	15,584.68
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	76,000.00

(See Appendix B 8.)

9. *Winthrop Harbor, Massachusetts.*—Winthrop Harbor is situated in the northeastern part of Boston Harbor. It contains 350 acres, approximately, all of which is essentially dry at low tide. The mean range of tides is 9.4 feet.

The original project for its improvement was based on the survey provided for in the act of August 5, 1886. It proposed to dredge a straight channel, 3,900 feet long, 50 feet wide, 6 feet deep at mean low water, from the "Back" channel of Boston Harbor to Rice's Wharf.

The river and harbor act of August 11, 1888, appropriated $1,000 for this harbor. This sum was insufficient to commence any operations that would be of benefit to commerce, and it has been retained in the Treasury.

No operations have been in progress or expenditures made during the fiscal year ending June 30, 1890.

The original condition of the harbor is unchanged.

July 1, 1889, amount available	$1,000.00
July 1, 1890, balance available	1,000.00
Amount appropriated by act of September 19, 1890	5,000.00
Amount available for fiscal year ending June 30, 1891	6,000.00

Amount (estimated) required for completion of existing project.....	$11,600.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix B 9.)

10. *Boston Harbor, Massachusetts.*—The object of this improvement is, first, to preserve the harbor by protecting the islands and headlands; and, second, to improve it by widening, straightening, and deepening the channels.

The projects adopted for this purpose since 1866 have been mainly in accordance with the recommendations of the United States commissioners, whose labors terminated during that year.

The works of preservation consist of sea-walls, aprons, jetties, etc., which protect the shores of the islands and headlands, prevent additional wash into the channels, control the tidal scour, and preserve the full height of anchorage shelter for vessels in the roadsteads. Such have been built or repaired at Point Allerton and the islands of Great Brewster, Lovells, Gallop's, Long, Deer, Rainsford, George's, and Castle.

The works of improvement have been by dredging and blasting, by which means many dangerous rocks and shoals have been removed and the main ship channel enlarged from 100 feet wide and 18 feet deep at mean low water so that it is now at least 600 feet wide and 23 feet deep at mean low water.

The following tributary channels have also been improved:

1. *Charles River.*—The natural channel of this river has been widened, straightened, and deepened, so that from its mouth up to Western Avenue Bridge, a distance of 4¾ miles, the channel has a width of 200 feet and a depth of 7 feet at mean low water; thence to Arsenal Street Bridge, 2½ miles, the channel has a least width of 80 feet and a least depth of 6 feet.

2. *Fort Point Channel.*—This important branch of the main ship-channel originally had a least depth of 12 feet at its entrance, and the channel was narrow and crooked. It has been widened to 175 feet and deepened to 23 feet at mean low water from its mouth to Congress Street Bridge, a distance of 1,900 feet.

3. *Hingham Harbor.*—(See separate report.)

4. *Nantasket Beach Channel.*—The project adopted in 1880 was to widen and deepen the channel so that it would be at least 100 feet wide and 9½ feet deep at mean low water. The project was completed in 1881 and 1883.

5. *Channel between Nix's Mate and Long Island.*—This channel had originally 4½ feet depth at mean low water. A cut has been made through the bar, 200 feet wide, 550 feet long, and 12 feet deep at mean low water.

6. *Broad Sound.*—An obstruction called "Barrel Rock" was removed in 1869.

The total expenditures to June 30, 1889, were $1,731,059.28.

During the fiscal year ending June 30, 1890, the extension of the sea-wall protecting Gallop's Island was completed; extensive repairs were made to the middle and north head sea-walls at Deer Island; 5,942 cubic yards of material were dredged from the upper middle; 111 cubic yards of ledge were removed from the Upper Middle; 9,025 cubic yards of material were dredged from the channel leading to Nantasket Beach; a detailed survey of the west end of Brewster Spit was made; and surveys, examinations, etc., were made for the Harbor Line Board.

At the date of this report the several works of preservation are in fair order; the main ship-channel is 23 feet deep at mean low water, 1,100

feet wide west of the Upper Middle, 750 feet wide at the Upper Middle, 1,000 feet wide at the Lower Middle, 625 feet wide at the Narrows, and 475 feet wide opposite the west end of Brewster Spit.

The subsidiary channels are in the same condition as at the date of the last report, with the exception of the one leading to Nautasket Beach, which has been widened to 250 feet at the turn opposite the Dolphin.

July 1, 1889, amount available		$42,501.02
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$14,753.18	
July 1, 1890, outstanding liabilities	2,280.32	
		17,033.50
July 1, 1890, balance available		25,467.52
Amount appropriated by act of September 19, 1890		145,000.00
Amount available for fiscal year ending June 30, 1891		170,467.52
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		395,000.00

(See Appendix B 10.)

11. *Hingham Harbor, Massachusetts.*—The object of the work is to widen and deepen the natural channel, which was 30 feet wide and 4 feet deep, so that it will be 100 feet wide and 10 feet deep at mean low water.

The project was originally proposed in 1874 and was modified in 1885. The original project was estimated to cost $11,000. The project of 1885 was to cost an additional sum of $18,750.

The amount expended to June 30, 1889, was $16,142.68. The condition of the improvement on that date was as follows:

The channel was 100 feet wide and 8 feet deep throughout, and at the ledge where operations have been in progress under the modified project the channel was 10 feet deep at mean low water in a cut through the ledge 50 feet wide.

At the commencement of the fiscal year operations were in progress under a contract to remove 200 cubic yards of ledge from the channel. During the fiscal year 93 cubic yards were removed under this contract (a total of 173 yards) at a total cost of $4,852.31, and at the date of this report the improved channel through the ledge is 100 feet wide, 10 feet deep at mean low water, and the remainder of its length but 8 feet deep.

The prospective benefits to commerce are increased facilities and safety to navigation.

July 1, 1889, amount available	$702.32
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	697.31
July 1, 1890, balance available	5.01
Amount appropriated by act of September 19, 1890	5,000.00
Amount available for fiscal year ending June 30, 1891	5,005.01
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	3,000.00

(See Appendix B 11.)

12. *Scituate Harbor, Massachusetts.*—This harbor is on the west shore of Massachusetts Bay, about 14 miles south of Boston Light.

The object of the improvement is to create a harbor of refuge for vessels bound to Boston from the eastward which are too far south of their true course to clear the dangerous ledges near Minot's Ledge Light.

Originally the harbor had a low-water area of about 57 acres, more than 6 acres of which had a depth of at least 3 feet at mean low water. It was entirely open to the action of easterly gales, and its entrance was obstructed by sunken bowlders.

The project adopted in 1880 is to build two breakwaters—one from "Cedar Point" on the north side of the entrance, and the other from the "First Cliff" on the south side—and to dredge the area inclosed and in front of the entrance. The estimated cost of the improvement is $290,000.

The expenditures to June 30, 1889, were $47,546.08.

The condition of the improvement June 30, 1889, was as follows:

The north breakwater was essentially completed. Nothing had been done on the south breakwater. The entrance channel was 1,600 feet long, 100 feet wide, and 5 feet deep at mean low water. The anchorage basin was 350 by 450 feet in area, 7 feet deep at mean low water.

A contract was in force on July 1, 1889, to dredge 9,000 cubic yards from a channel leading from the anchorage basin to the town wharves 2,100 feet long, 25 feet wide, and 1 foot deep at mean low water.

During the year 8,386 cubic yards were dredged under this contract at an expense of $4,124.12, and at the date of this report a navigable channel connects the anchorage basin with the town wharves 2,100 feet long, 25 feet wide, 1 foot deep at mean low water.

The condition of the breakwaters, the entrance channel, and the anchorage basin are the same as on June 30, 1889.

The prospective benefits to commerce by the completion of this improvement are the creation of an additional harbor of refuge on this much frequented dangerous coast.

July 1, 1889, amount available	$903.92
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	74.12
July 1, 1890, balance available	829.80
Amount appropriated by act of September 19, 1890	10,000.00
Amount available for fiscal year ending June 30, 1891	10,829.80
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	227,500.00

(See Appendix B 12.)

13. *Plymouth Harbor, Massachusetts.*—Plymouth Harbor is 30 miles south of Boston.

The object of its improvement is to perpetuate the harbor by the preservation of Long Beach, which forms it; and to deepen and widen the channels of approach to an enlarged anchorage basin in front of the town wharves.

The various devices employed for the preservation of Long Beach are described in the Annual Report of the Chief of Engineers for the year 1877.

The original project for improvement was adopted in 1875 and modified in 1877 and 1884. The modified project proposed an improved channel 2,286 feet long, 150 feet wide, and 9 feet deep at mean low water.

The expenditures to June 30, 1889, were, for beach protection, $73,031.73; for dredging, $42,271.02; total, $115,302.75.

At that date the channel was 115 feet wide, 9 feet deep at mean low water; the basin was 800 feet long, 9 feet deep for 90 feet of its width nearest the town wharves, and averaged 5 feet deep for the remainder of its width.

On June 30, 1889, a contract was in force to dredge 13,000 cubic yards from the basin. During the year 13,000 cubic yards were dredged under this contract, at a cost of $5,169.57, from the basin, and at the date of this report the basin is 800 feet long, averages 150 feet wide, 9 feet deep at mean low water.

The improved channel and the condition of Long Beach are the same as at the date of the last report.

The prospective benefits to commerce are increased facilities and safety to navigation.

July 1, 1889, amount available	$1,613.50
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	285.82
July 1, 1890, balance available	1,327.68
Amount appropriated by act of September 19, 1890	8,000.00
Amount available for fiscal year ending June 30, 1891	9,327.68
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	9,500.00

(See Appendix B 13.)

14. *Wellfleet Harbor, Massachusetts.*—Wellfleet Harbor is 12 miles southeast of Provincetown, on Cape Cod Bay.

The object of its improvement is to provide a navigable channel from the inner anchorage, the "Deep Hole," to the town wharves.

The project originally proposed in 1871 was to dredge two channels of approach to the town wharves and to remove several dangerous sunken rocks.

The removal of the sunken rocks was effected by an appropriation provided by the act of June 10, 1872.

The present project is to dredge a channel from the "Deep Hole" to the town wharves 4,200 feet long, 100 feet wide, and 6 feet deep at mean low water.

The expenditures to June 30, 1889, were $5,043.54. The condition of the improvement at that date was as follows: 204 cubic yards of sunken rocks had been removed from the harbor, and no low-water channel existed to the town wharves.

On June 30, 1889, a contract was in force to dredge a channel 2,500 feet long, 25 feet wide, and 4 feet deep at mean low water from the "Deep Hole" to the town wharves.

During the fiscal year 16,984 cubic yards were dredged under this contract, at an expense of $6,296.25, and at the date of this report a channel 25 feet wide and 4 feet deep extends from the "Deep Hole" to the town wharves.

July 1, 1889, amount available	$746.46
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	86.25
July 1, 1890, balance available	660.21
Amount appropriated by act of September 19, 1890	4,000.00
Amount available for fiscal year ending June 30, 1891	4,660.21
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	22,000.00

(See Appendix B 14.)

15. *Provincetown Harbor, Massachusetts.*—Provincetown Harbor is situated at the extremity of Cape Cod, about 40 miles southeast from Boston

Light. It is one of the most valuable harbors of refuge on the Atlantic coast. The entire commerce of New England and a very large local fishing interest are directly benefited by its maintenance, which depends entirely on the preservation of the sandy beaches which inclose it.

Since 1826 the project has been a general one, and provides for the preservation of the harbor by building dikes, bulkheads, and sand-catches, and extensive planting of beach grass to repair and prevent storm damages to the beaches.

From the nature of the work it can at no time be considered completed. A special dike across House Point Island Flats, to be built contingently, was recommended in the annual report for 1886.

A plan of the harbor was published in the Annual Report of the Chief of Engineers for 1886.

The amount expended to June 30, 1889, was $141,043.27, and on that date the several works of preservation were in good order.

During the fiscal year the "leveling up" and backing of the Long Point breakwater were completed; a total of 1,188 tons of stone and 150 cords of brush were added to the breakwater. Some minor repairs and extensions of the sand-catches near Abel Hill Dike were made.

The amount expended during the year was $3,010.39.

At the date of this report all the works of preservation are in good order, but the central part of Long Point needs a new bulkhead 2,000 feet long, to cost $6,000.

The prospective benefit to commerce is the preservation of an important harbor of refuge.

July 1, 1889, amount available	$3,991.47
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	576.69
July 1, 1890, balance available	3,414.78
Amount appropriated by act of September 19, 1890	7,500.00
Amount available for fiscal year ending June 30, 1891	10,914.78

(See Appendix B 15.)

16. *Removal of sunken vessels or craft obstructing or endangering navigation.*—The wreck of the schooner *Anna A. Holton* in Provincetown Harbor, Massachusetts, and the wreck of the schooner *John E. Sanford* in Newburyport Harbor, Massachusetts, were examined, advertised, and removed by contract, in accordance with the act of 1880.

The cost of removal was $2,007.84, and nothing of value was saved.

Amount allotted July 12, 1889, $1,000; amount allotted November 6, 1889, $3,000		$4,000.00
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$2,007.84	
Deposited to credit of United States Treasurer	1,992.16	
		4,000.00

(See Appendix B 16.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENT, TO COMPLY WITH REQUIREMENTS OF RIVER AND HARBOR ACT OF AUGUST 11, 1888.

It appearing from the preliminary examination made by the local engineer that the following localities are worthy of improvement, and the public necessity therefor being apparent from the facts and reasons reported, which are concurred in by the Chief of Engineers, Lieutenant-Colonel Mansfield was charged with and completed their sur-

vey, the results of which were transmitted to Congress and printed in Ex. Doc's of the Fifty-first Congress, first session.

1. *Crane and Waters Rivers of Essex Branch, Massachusets.*—Printed as House Ex. Doc. 23. (See also Appendix B 17.)

2. *Weymouth (Fore) River, Massachusetts.*—Printed as House Ex. Doc. 26. (See also Appendix B 18.)

3. *Beverly Harbor, Massachusetts.*—Printed as House Ex. Doc. 27. (See also Appendix B 19.)

4. *Salem Harbor, including South River, Massachusetts.*—Printed as House Ex. Doc. 28. (See also Appendix B 20.)

IMPROVEMENT OF HARBORS AND RIVERS ON THE SOUTHERN COAST OF MASSACHUSETTS AND IN RHODE ISLAND AND CONNECTICUT.

Officer in charge, Maj. W. R. Livermore, Corps of Engineers; Division Engineer, Col. H. L. Abbot, Corps of Engineers.

1. *Harbor of Refuge at Hyannis, Massachusetts.*—This harbor, before improvement, was an open roadstead exposed to southerly storms. In the years 1827–1838 a breakwater of riprap granite 1,170 feet long was constructed, covering an anchorage of about 175 acres, the entrance to which has a depth of about 15½ feet. Between the years 1852 and 1882 extensive repairs were made in increasing the width of its base and the size of the stone forming its sides and top.

The depth of water immediately inside the breakwater being insufficient for many vessels that seek the harbor for refuge, the present project for the improvement of the harbor contemplates dredging the area protected by the breakwater to a depth of 15½ feet at mean low water.

The amount expended on this work up to June 30, 1889, was $129,395.81. The breakwater had been completed according to the original project and subsequent plans for strengthening it, and the 15½-foot anchorage area had been increased by about 6$\frac{9}{10}$ acres.

At the beginning of the last fiscal year no work was in progress. On account of the exposed position of the dumping ground it has not been the practice to attempt any work of dredging in this harbor except during the summer season. During the summer of 1889 no plant could be obtained for this work; the work, however, is now in progress with plant owned by the Government.

The amount expended during the last fiscal year including liabilities outstanding June 30, 1890, was $12,045.77, and the result was the commencement of the work of dredging in the 15½-foot anchorage area protected by the breakwater, and the purchase of dredging plant to the value of $9,937.30.

July 1, 1889, amount available		$13,961.77
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$10,439.82	
July 1, 1890, outstanding liabilities	1,605.95	
		12,045.77
July 1, 1890, balance available		1,916.00
Amount appropriated by act of September 19, 1890		8,000.00
Amount available for fiscal year ending June 30, 1891		9,916.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		17,662.00

(See Appendix C 1.)

2. *Harbor of Refuge at Nantucket, Massachusetts.*—This harbor is the only one between the harbors of Martha's Vineyard (Vineyard Haven and Edgartown) and Provincetown, a distance of about 100 miles, except the small harbor of Hyannis, on the north side of Nantucket Sound. It has deep water inside, and the object of improvement is to make it a harbor of refuge for vessels plying between ports north and south of Cape Cod.

Before the commencement of the present work there was a shoal about 1½ miles in width outside the entrance, through which the channel or line of best water was only about 6 feet deep, and very crooked and subject to changes in location.

The present approved project is to construct jetties of riprap stone, projecting from either side of the present entrance to the harbor, for the purpose of concentrating the strength of the tidal currents and excavating a channel of 15 feet depth by scour, and at the places where the full depth required will not be reached by this means to complete the work by dredging.

The amount expended on this project up to the close of the fiscal year ending June 30, 1889, was $141,803.77, and the result was the construction of the west jetty to a point 3,955 feet from the shore, and the east jetty to a distance of 400 feet from its initial point on shore, which is the outer end of the middle of the three northwest spurs built on Coatue Beach some years ago, and the foundation was laid and the jetty partially completed for an additional distance of 200 feet.

The construction of the east jetty was continued during the year, and 6,885 tons of stone were placed in the work.

The amount expended during the last fiscal year, including outstanding liabilities to June 30, 1890, was $3,147.53, and the result was the completion of the eastern jetty to a distance of 834 feet from the initial point on shore, and its partial construction for an additional distance of 191 feet, and the purchase of plant to the value of $3,045.99.

The cost of constructing this jetty has been more than doubled, from the fact that the appropriations have been so small that only short sections could be built each year. The currents wash away the sand around the head of the jetty, so that it becomes necessary to lay the foundation in 12 or 14 feet of water instead of 4 or 5 feet.

July 1, 1889, amount available		$3,196.23
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$2,664.42	
July 1, 1890, outstanding liabilities	483.11	
		3,147.53
July 1, 1890, balance available		48.70
Amount appropriated by act of September 19, 1890		25,000.00
Amount available for fiscal year ending June 30, 1891		25,048.70
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		205,000.00

(See Appendix C 2.)

3. *Harbor at Vineyard Haven, Massachusetts.*—The plan of improvement contemplates the protection of the points of land at the entrance to the harbor known as East Chop and West Chop, by the construction of jetties and other works along the shore to stop the wearing away of the chops by the action of the storm waves.

The amount expended on this project up to the close of the fiscal year ending June 30, 1889, including outstanding liabilities, was

$3,922.72, and the result was the temporary wharf at West Chop, for the landing of material for the experimental jetties, was partially built, and 253 tons of stone were placed in two of the jetties.

At the beginning of the last fiscal year work was in progress on a temporary wharf at West Chop, on which the material for the experimental jetties was to be landed. This wharf and three jetties have been completed. They extend from the foot of the bluff out to about 4 feet of water at mean low water, a distance of from 80 to 150 feet and are 200 feet apart. Two of these jetties were built last fall, the space between them rapidly filled with sand and the shore-line was extended an average distance of 20 feet into the water. The improvement in the beach has been maintained.

Work of a similar character is now in progress at East Chop.

Eight hundred and forty tons of stone were placed in the work of which 375 tons were from a quarry at Mason's Island, Connecticut, operated by the Government. The remainder was purchased in open market.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1890, was $19,416.28, and the result was the construction of the wharf and the three jetties above mentioned, and the purchase of plant to the value of $8,938.26.

The balance available will be applied to continuing the work of protection, beginning at East Chop.

July 1, 1889, amount available		$21,077.28
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$15,718.23	
July 1, 1890, outstanding liabilities	3,698.05	
		19,416.28
July 1, 1890, balance available		1,661.00
Amount appropriated by act of September 19, 1890		10,000.00
Amount available for fiscal year ending June 30, 1891		11,661.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		25,000.00

(See Appendix C 3.)

4. *Wareham Harbor, Massachusetts.*—The object of the improvement is to deepen and widen the channel leading from Buzzard's Bay to Wareham. The commerce of Wareham is carried on in sailing vessels, and the channel is to be made a beating channel for such vessels. Another object of the improvement is the raising of Long Beach.

Before improvement the ruling depth in the harbor was about 7 feet at mean low water in a narrow and very crooked channel. Long Beach, a narrow sand spit at the mouth of the harbor, was washed and abraded by the waves and currents at high water, and the material was carried into and shoaled the channel inside.

The original approved project of 1871, for the improvement and its subsequent modifications, provides for a channel 250 feet wide and 10 feet deep at mean low water from Barney's Point down to the entrance to the harbor. Above Barney's Point the width of the channel is to be 350 feet, with the same depth—10 feet—as below that point. The plan includes also the raising and strengthening of Long Beach, of which a large portion was submerged at low water, to carry it above the storm waves and currents and to hold it there, in order to prevent the filling of the improved channel above, by material abraded from the beach.

The total amount expended on the improvement up to the close of the fiscal year ending June 30, 1889, including outstanding liabilities at that date, was $73,047.20, and the result was that the channel in the upper part of the harbor in front of the wharves was carried to its full width and completed, and the eastern half of the second and third reaches below the wharves, and about two-thirds of the eastern half of the fourth reach, which extends to Barney's Point, were deepened to 10 feet at mean low water. The channel for about one-half its width from Barney's Point to Wareham has been deepened to 10 feet. Long Beach has been raised above high-water storm-tides, so that the wash of sand into the improved channel inside the beach has been stopped.

The ruling depth of the approaches to Wareham has been increased from 7 to 9 feet, and the channel greatly widened in all the reaches. Vessels of larger draught can be carried to Wareham than formerly. The increase in width of channel is a great help to all vessels in beating in and out of the harbor.

At the beginning of the last fiscal year no work was in progress. Dredging was resumed in November, 1889, with hired plant, and was continued until December 7, when the plant was withdrawn by the owners, for fear it would be frozen in. March 10, 1890, work was resumed with a dredge owned by the United States and continued until March 28, 1890. The work was confined to the Middle Ground, which was a shoal in mid-channel of Reach No. 9. The amount expended during the last fiscal year, including liabilities outstanding June 30, 1890, was $10,921.43, and the result was the completion of the southern half of Reach No. 8 to a width of 175 feet and depth of 10 feet, the removal of the Middle Ground and the purchase of plant to the value of $3,690.36.

July 1, 1889, amount available		$10,952.90
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$10,807.51	
July 1, 1890, outstanding liabilities	113.92	
		10,921.43
July 1, 1890, balance available		31.47
Amount appropriated by act of September 19, 1890		5,000.00
Amount available for fiscal year ending June 30, 1891		5,031.47
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		7,236.00

(See Appendix C 4.)

5. *New Bedford Harbor, Massachusetts.*—Before improvement the channel had a depth of about 12½ feet at mean low water. The original project for its improvement as modified in 1877 provided for a channel 300 feet wide and 15 feet deep at mean low water from the deep water just above Palmer's Island to the wharves at New Bedford. This project was completed in 1877 at a cost of $20,000.

The object of the present improvement is to provide a channel 200 feet wide and 18 feet deep at mean low water.

The amount expended to June 30, 1889, including outstanding liabilities at that date, was $20,991. The result was the excavation of the channel, under the original project and its modifications, to a width of 300 feet and a depth of 15 feet at mean low water.

The work of dredging was resumed during the past fiscal year and 43,665 cubic yards of mud, sand, and gravel were excavated.

On June 30, 1889, a contract was in force to dredge 13,000 cubic yards from the basin. During the year 13,000 cubic yards were dredged under this contract, at a cost of $5,169.57, from the basin, and at the date of this report the basin is 800 feet long, averages 150 feet wide, 9 feet deep at mean low water.

The improved channel and the condition of Long Beach are the same as at the date of the last report.

The prospective benefits to commerce are increased facilities and safety to navigation.

July 1, 1889, amount available	$1,613.50
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	285.82
July 1, 1890, balance available	1,327.68
Amount appropriated by act of September 19, 1890	8,000.00
Amount available for fiscal year ending June 30, 1891	9,327.68
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	9,500.00

(See Appendix B 13.)

14. *Wellfleet Harbor, Massachusetts.*—Wellfleet Harbor is 12 miles southeast of Provincetown, on Cape Cod Bay.

The object of its improvement is to provide a navigable channel from the inner anchorage, the "Deep Hole," to the town wharves.

The project originally proposed in 1871 was to dredge two channels of approach to the town wharves and to remove several dangerous sunken rocks.

The removal of the sunken rocks was effected by an appropriation provided by the act of June 10, 1872.

The present project is to dredge a channel from the "Deep Hole" to the town wharves 4,200 feet long, 100 feet wide, and 6 feet deep at mean low water.

The expenditures to June 30, 1889, were $5,043.54. The condition of the improvement at that date was as follows: 204 cubic yards of sunken rocks had been removed from the harbor, and no low-water channel existed to the town wharves.

On June 30, 1889, a contract was in force to dredge a channel 2,500 feet long, 25 feet wide, and 4 feet deep at mean low water from the "Deep Hole" to the town wharves.

During the fiscal year 16,984 cubic yards were dredged under this contract, at an expense of $6,296.25, and at the date of this report a channel 25 feet wide and 4 feet deep extends from the "Deep Hole" to the town wharves.

July 1, 1889, amount available	$746.46
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	86.25
July 1, 1890, balance available	660.21
Amount appropriated by act of September 19, 1890	4,000.00
Amount available for fiscal year ending June 30, 1891	4,660.21
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	22,000.00

(See Appendix B 14.)

15. *Provincetown Harbor, Massachusetts.*—Provincetown Harbor is situated at the extremity of Cape Cod, about 40 miles southeast from Boston

to the west shore of the river, with the view of accelerating the current in the dredged channel off and above Dighton, and preventing deposits in this part of the channel. Vessels of 11-feet draught can now reach Taunton, at the head of navigation.

No work was done during the last fiscal year.

There remains to complete the existing project, widening and deepening at a few points above the bridge and the removal of the small amount of ledge rock above referred to. A map of a survey of parts of Taunton River, with report thereon and project for further improvement, were submitted to Congress January 10, 1888, and printed as House Ex. Doc. No. 86, Fiftieth Congress, first session.

July 1, 1889, amount available		$32.28
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$4.50	
July 1, 1890, outstanding liabilities	15.00	
		19.50
July 1, 1890, balance available		12.78
Amount appropriated by act of September 19, 1890		7,000.00
Amount available for fiscal year ending June 30, 1891		7,012.78
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		7,000.00

(See Appendix C 6.)

7. *Warren River, Rhode Island.*—Warren River is an arm of Narragansett Bay north of the harbor of Bristol. The obstructions to navigation were a rocky reef below Little Island and a submerged bowlder near mid-channel opposite the lower wharves of the town of Warren. The approved project provided for the removal of these obstructions as far as could be done with an expenditure of $5,000.

The submerged bowlder was removed and an area of about 1.8 acres extending 550 feet along the narrowest part of the channel was cleared of the projecting points of ledge and bowlders between the months of August and November, 1887.

This completed the improvement as far as projected.

July 1, 1889, amount available		$119.78
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$93.99	
July 1, 1890, outstanding liabilities	16.86	
		110.85
July 1, 1890, balance available		8.93

(See Appendix C 7.)

8. *Pawtucket River, Rhode Island.*—Before improvement the channel in the river had a ruling depth of about 5 feet at mean low water.

The project for its improvement, as modified in 1883, provides for the excavation by dredging of a channel 100 feet wide and 12 feet deep at mean low water from the deep water above Red Bridge to the ledge opposite Grant & Company's Wharf at Pawtucket; thence the deepening by blasting of a channel through the ledge to Pawtucket Bridge of the same depth and 40 feet wide.

The amount expended to June 30, 1889, was $134,505.83. The channel had been excavated under the original project to a width of 75 feet and a ruling depth of 7 feet at mean low water, and under the project as modified in 1883 a new channel 12 feet deep and 100 feet wide, with

vey, the results of which were transmitted to Congress and printed in Ex. Doc's of the Fifty-first Congress, first session.

1. *Crane and Waters Rivers of Essex Branch, Massachusets.*—Printed as House Ex. Doc. 23. (See also Appendix B 17.)

2. *Weymouth (Fore) River, Massachusetts.*—Printed as House Ex. Doc. 26. (See also Appendix B 18.)

3. *Beverly Harbor, Massachusetts.*—Printed as House Ex. Doc. 27. (See also Appendix B 19.)

4. *Salem Harbor, including South River, Massachusetts.*—Printed as House Ex. Doc. 28. (See also Appendix B 20.)

IMPROVEMENT OF HARBORS AND RIVERS ON THE SOUTHERN COAST OF MASSACHUSETTS AND IN RHODE ISLAND AND CONNECTICUT.

Officer in charge, Maj. W. R. Livermore, Corps of Engineers; Division Engineer, Col. H. L. Abbot, Corps of Engineers.

1. *Harbor of Refuge at Hyannis, Massachusetts.*—This harbor, before improvement, was an open roadstead exposed to southerly storms. In the years 1827–1838 a breakwater of riprap granite 1,170 feet long was constructed, covering an anchorage of about 175 acres, the entrance to which has a depth of about 15½ feet. Between the years 1852 and 1882 extensive repairs were made in increasing the width of its base and the size of the stone forming its sides and top.

The depth of water immediately inside the breakwater being insufficient for many vessels that seek the harbor for refuge, the present project for the improvement of the harbor contemplates dredging the area protected by the breakwater to a depth of 15½ feet at mean low water.

The amount expended on this work up to June 30, 1889, was $129,395.81. The breakwater had been completed according to the original project and subsequent plans for strengthening it, and the 15½-foot anchorage area had been increased by about 6$\frac{2}{10}$ acres.

At the beginning of the last fiscal year no work was in progress. On account of the exposed position of the dumping ground it has not been the practice to attempt any work of dredging in this harbor except during the summer season. During the summer of 1889 no plant could be obtained for this work; the work, however, is now in progress with plant owned by the Government.

The amount expended during the last fiscal year including liabilities outstanding June 30, 1890, was $12,045.77, and the result was the commencement of the work of dredging in the 15½-foot anchorage area protected by the breakwater, and the purchase of dredging plant to the value of $9,937.30.

July 1, 1889, amount available		$13,961.77
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$10,439.82	
July 1, 1890, outstanding liabilities	1,605.95	
		12,045.77
July 1, 1890, balance available		1,916.00
Amount appropriated by act of September 19, 1890		8,000.00
Amount available for fiscal year ending June 30, 1891		9,916,00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		17,662.00

(See Appendix C 1.)

The amount expended on the present project up to the close of the fiscal year ending June 30, 1889, including liabilities outstanding at that date, was $246,883.36. At that date the 25-foot channel 300 feet wide had been completed. Bulkhead Rock had been removed. The excavation of the 20-foot anchorage area had been completed in Fox Point Reach, and of the same areas in the Sassafras Point and the Field's Point reaches about one-fourth and one-half respectively had been done.

At the beginning of the last fiscal year no work was in progress. Dredging was commenced, with hired plant, in August, 1889, and continued until November 9. Dredging was also carried on in December, 1889, and January and February, 1890—the work of December being done with a dredge owned by the United States. During the fiscal year 96,034 cubic yards of mud were excavated.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1890, was $36,717.27, and the result was the completion of the 20-foot anchorage area on the east side of the Sassafras Point Reach, and 18-foot area on the east side of the Fox Point Reach, and about three-fourths of the 18-foot area on the same side of the Sassafras Point Reach, and the purchase of plant to the value of $18,326.53.

There is required for the completion of the existing project the excavation of the remainder of the anchorage basin between Fox and Field's Points.

July 1, 1889, amount available		$36,717.27
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$35,829.71	
July 1, 1890, outstanding liabilities	887.56	
		36,717.27
Amount appropriated by act of September 19, 1890		50,000.00
Amount (estimated) required for completion of existing project ..... Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		115,000.00

(See Appendix C 9.)

10. *Removal of Green Jacket Shoal, Providence River, Rhode Island.*—This shoal is in that part of Providence River which constitutes the harbor of Providence. It lies off the wharves, on the south front of the city, and occupies a part of the harbor that is required for anchorage purposes, covering an area of about 18 acres between the 15-foot curves.

The adopted project is the removal of the entire shoal to a depth of 25 feet at mean low water, limiting the work by lines drawn 200 feet from the harbor lines.

The amount expended, including outstanding liabilities to June 30, 1889, was $28,064.37, and the result was the excavation of an area of about 9¼ acres on the western side of the shoal to a depth of 25 feet at mean low water, making an important addition to the anchorage facilities of Providence Harbor.

At the beginning of the last fiscal year no work was in progress. Dredging was commenced with hired plant in August, 1889, and continued until November 9. From January 6 to February 8, 1890, the work was prosecuted with a dredge owned by the United States. The amount of material excavated was 147,520 cubic yards of mud and oyster shells.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1890, was $26,185.63, and the result was the en-

$3,922.72, and the result was the temporary wharf at West Chop, for the landing of material for the experimental jetties, was partially built, and 253 tons of stone were placed in two of the jetties.

At the beginning of the last fiscal year work was in progress on a temporary wharf at West Chop, on which the material for the experimental jetties was to be landed. This wharf and three jetties have been completed. They extend from the foot of the bluff out to about 4 feet of water at mean low water, a distance of from 80 to 150 feet and are 200 feet apart. Two of these jetties were built last fall, the space between them rapidly filled with sand and the shore-line was extended an average distance of 20 feet into the water. The improvement in the beach has been maintained.

Work of a similar character is now in progress at East Chop.

Eight hundred and forty tons of stone were placed in the work of which 375 tons were from a quarry at Mason's Island, Connecticut, operated by the Government. The remainder was purchased in open market.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1890, was $19,416.28, and the result was the construction of the wharf and the three jetties above mentioned, and the purchase of plant to the value of $8,938.26.

The balance available will be applied to continuing the work of protection, beginning at East Chop.

July 1, 1889, amount available		$21,077.28
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$15,718.23	
July 1, 1890, outstanding liabilities	3,698.05	
		19,416.28
July 1, 1890, balance available		1,661.00
Amount appropriated by act of September 19, 1890		10,000.00
Amount available for fiscal year ending June 30, 1891		11,661.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		25,000.00

(See Appendix C 3.)

4. *Wareham Harbor, Massachusetts.*—The object of the improvement is to deepen and widen the channel leading from Buzzard's Bay to Wareham. The commerce of Wareham is carried on in sailing vessels, and the channel is to be made a beating channel for such vessels. Another object of the improvement is the raising of Long Beach.

Before improvement the ruling depth in the harbor was about 7 feet at mean low water in a narrow and very crooked channel. Long Beach, a narrow sand spit at the mouth of the harbor, was washed and abraded by the waves and currents at high water, and the material was carried into and shoaled the channel inside.

The original approved project of 1871, for the improvement and its subsequent modifications, provides for a channel 250 feet wide and 10 feet deep at mean low water from Barney's Point down to the entrance to the harbor. Above Barney's Point the width of the channel is to be 350 feet, with the same depth—10 feet—as below that point. The plan includes also the raising and strengthening of Long Beach, of which a large portion was submerged at low water, to carry it above the storm waves and currents and to hold it there, in order to prevent the filling of the improved channel above, by material abraded from the beach.

Work was commenced, with hired plant, in August, 1889, and continued, excepting for a part of the month of September. Dredging was also done in February and March, 1890. During a part of the season a dredge belonging to the United States was employed on the work, besides the plant mentioned above. Thirty-nine thousand six hundred and one cubic yards of material were excavated from the 13-foot and 15-foot areas, and in addition a small amount of work was done near the north end of Goat Island.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1890, was $10,712.82, and the result was the completion of the 13-foot anchorage area and the dredging of one cut along the western edge of the 15-foot channel north of the dolphin and the purchase of plant to the value of $355.40.

The work required to complete the existing project is the dredging of the remainder of the narrow strip along the western edge of the 15-foot channel north of the dolphin and the excavation of the 10-foot anchorage area, also the building of additional jetties outside of Goat Island whenever they may be required to arrest the drift of littoral sand and gravel into the harbor entrance.

July 1, 1889, amount available		$10,712.82
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	10,701.14	
July 1, 1890, outstanding liabilities	11.68	
		10,712.82
Amount appropriated by act of September 19, 1890		12,500.00
Amount (estimated) required for completion of existing project Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		27,500.00

(See Appendix C 11.)

12. *Harbor of Refuge at Block Island, Rhode Island.*—The object of the improvement is to furnish a harbor of refuge for vessels engaged in foreign and coastwise commerce.

Before the construction of the present harbor Block Island had no harbor which afforded protection for decked vessels. The original project and its subsequent modifications provide for a harbor of refuge on the eastern side of the island, consisting of an inner harbor or basin for small vessels and an exterior for large ones. The basin was to be about 250 feet by 300 feet in area and inclosed, with the exception of an opening 80 feet wide. The exterior harbor was to be formed by a riprap breakwater, which has been built. About 300 feet from the sea end of this breakwater, which is 1,900 feet long, a gap 200 feet long was left for the convenience of vessels. The present project contemplates the filling of this gap and restoring the breakwater to its original dimensions, the enlargement of the inner harbor, and the removal of a shoal along the western side of the breakwater.

The total expenditures up to June 30, 1889, were $340,931.39.

The inner harbor and the main breakwater, built in prolongation of the eastern side of the inner harbor, and extending 1,900 feet from the shore, were constructed in the years 1870 to 1879, inclusive. The utility of the work at once became apparent. In stormy weather the inner harbor, especially, was filled with fishermen and coasters, and it soon became necessary to increase its depth from 7 feet, to which it had been dredged in the first instance, to 9 feet at mean low water. A strong jetty had been built out from the cliff to the eastward of the inner harbor, and a masonry wall constructed on the inside of the crib-work

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1890, was $8,975.02, and the result was the excavation of a channel to a depth of 18 feet at mean low water, and a width of 100 feet, from the deep water of Buzzard's Bay near the 11-foot bank to the vicinity of the wharves in New Bedford, and the purchase of dredging plant to the value of $1,104.49.

The work required to complete the existing project is the excavation of the remaining half of the channel 200 feet wide and 18 feet deep, extending from the "11-foot bank" to the vicinity of the wharves at New Bedford, and the removal of a few shoal spots between the "11-foot bank" and Butler's Flats, the southern end of the projected channel.

July 1, 1889, amount available		$9,009.00
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$8,951.47	
July 1, 1890, outstanding liabilities	23.55	
		8,975.02
July 1, 1890, balance available		33.98
Amount appropriated by act of September 19, 1890		10,000.00
Amount available for fiscal year ending June 30, 1891		10,033.98
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		15,000.00

(See Appendix C 5.)

6. *Taunton River, Massachusetts.*—The object of the improvement is to deepen and widen the channel leading to the city of Taunton, at the head of navigation, so that vessels of 11 feet draught can reach the city at high water.

In its original condition the channel was narrow and obstructed by bowlders, and from Berkley Bridge to Taunton the depth was not, in places, more than 5 feet at mean high water. A vessel of 30 tons burden was as large as could go up to Taunton.

The approved project of 1871 and its subsequent modifications provide for a channel 60 feet wide and 11 feet deep from Weir Bridge to the ship-yard, a channel 80 feet wide (100 feet at the bends) and 11 feet deep from the ship-yard down to and through the Needles and Briggs's Shoal; thence to Berkley Bridge a channel of the same width and 12 feet deep, and from Berkley Bridge to the deep water at Dighton the channel was to be 100 feet wide and 12 feet deep. The depths are estimated from high water. The ledge which crossed the bottom of the river at Peter's Point, and the numerous bowlders which lay on the bottom and sides of the channel from Taunton to Dighton, were to be removed. The amount expended on the improvement of the river up to the close of the fiscal year ending June 30, 1889, was $156,967.72.

With the exception that but 40 feet of the 60 feet of width could be dredged between the bridge at Weir and the ship-yard, on account of interfering with private property, and that on account of the hardness and depth of material at the sides the 80-foot channel was not in all cases dredged to its full width, the channel down to Berkley Bridge had been completed. The channel as proposed between Berkley Bridge and Dighton had been completed—with the exception of removing a small amount of ledge rock uncovered in dredging below Peter's Point—and had been cleared of bowlders from Taunton down to Berkley Bridge. The work of removal of the ledge at Peter's Point had been completed. The material blasted in the channel had been dredged and deposited in the form of a half-tide dam running from Reuben's Island

The amount expended on the present project to June 30, 1889, including outstanding liabilities, was $11,288.77, and the result was the completion of the channel to its full width and depth from the deep water opposite the village of Lottery to a point near the lower end of Major's Island, with the exception of a small amount of ledge rock which extends into the channel near Certain Draw Point and at Pawcatuck Rock.

At the beginning of the last fiscal year no work was in progress. Operations were resumed July 29, 1889, and between that date and October 30, 1889, 339¼ tons of rock were removed from the ledges at Certain Draw Point and Pawcatuck Rock. Dredging was commenced March 9, 1890, with hired plant, and was continued until April 5. Seven thousand five hundred and nine yards of sand and gravel were excavated.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1890, was $9,573.85, and the result was that the channel was cleared of obstructions and extended to a point near the upper end of Major's Island, and the purchase of plant to the value of $1,761.54.

July 1, 1889, amount available		$9,573.85
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$9,091.81	
July 1, 1890, outstanding liabilities	482.04	
		9,573.85
Amount appropriated by act of September 19, 1890		16,600.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		37.00

(See Appendix C 13.)

14. *Harbor of refuge at Stonington, Connecticut.*—Stonington Harbor originally was an open bay, unprotected from southerly storms and obstructed by a shoal having a low-water depth of but 6 feet at the shoalest part. A short breakwater was constructed in the years 1828–1831, at a cost of $34,766.65, for the protection of the commerce of the town. The enlarged project of 1871 for the improvement of the harbor and its subsequent modification, under which work is now carried on, embraced dredging in the upper harbor and the construction of two breakwaters in the outer harbor. One of these, the western, was to be built out from Wamphassuck Point, the southwestern limit of the harbor, and to extend about 2,000 feet; and the other, the eastern, was to extend from the vicinity of Bartlett's Reef to the Middle Ground. The western breakwater was completed in 1880 at a cost of $103,190. The amount expended in dredging in the upper harbor was about $45,000. The position of the western end of the eastern breakwater has not been determined.

The amount expended on the eastern breakwater up to the close of the fiscal year ending June 30, 1889, was $114,989.66, and its length at that date was 2,240 feet.

At the beginning of the last fiscal year the work of constructing the eastern breakwater was in progress under the contract of February 8, 1889, with Charles F. Stoll of New London, Conn., which was finished August 17, 1889. One thousand nine hundred and twenty-five tons of stone were placed during the fiscal year.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1890, was $862.57, and the result was the extension

wide enlargements at the bends, had been carried from its mouth at the deep water just above Red Bridge, a distance of about 12,740 feet.

There is now a channel 100 feet wide and 12 feet deep at mean low water from the deep water above Red Bridge to within 1¼ miles of the head of navigation.

This completed portion of the channel is already a great benefit to the commerce of the river; a ruling depth of about 6 feet can be carried from the upper end of our present work to Pawtucket.

At the beginning of the last fiscal year no work was in progress. Dredging was commenced, with hired plant, in August, 1889, and continued, with the exception of a part of the months of November and December, to January 23, 1890. During the fiscal year 54,923 cubic yards of sand and 128 cubic yards of bowlders and ledge rock, besides numerous stumps, logs, and fallen trees, were excavated from the projected channel.

The amount expended during the last fiscal year, including liabilities outstanding to June 30, 1890, was $32,500.13, and the result was the dredging of the channel to a width of 60 feet, from Bass Rock to a point about 200 feet above Dunnell's Wharf, and the purchase of dredging plant to the value of $10,805.61.

The work yet to be done is to excavate the channel to its full width of 100 feet from Bass Rock to a point opposite Grant & Co.'s Wharf, and thence to Pawtucket Bridge, to deepen the channel through the ledge to the same depth, with a width of 40 feet.

It is proposed to extend the channel towards Pawtucket by dredging and to commence work on the ledge.

July 1, 1889, amount available		$32,500.13
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$31,844.08	
July 1, 1890, outstanding liabilities	656.05	
		32,500.13
Amount appropriated by act of September 19, 1890		30,000.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		337,478.00

(See Appendix C 8.)

9. *Providence River and Narragansett Bay, Rhode Island.*—The object of this improvement is to furnish a wide and deep channel for foreign and coastwise commerce from the ocean to Providence.

Before the improvement of the river was commenced in 1853 many shoals obstructed navigation, and at one point in the channel, a place called "The Crook," the available low-water depth was but 4½ feet. There was expended between 1852 and the 30th of June, 1882, $290,459.34 in deepening the channel, first to 9 feet, then to 12 feet, then to 14 feet, and again to 23 feet, as the increasing sizes of vessels and the growing commerce of Providence demanded. Bulkhead Rock was also removed during this period to a depth of 20 feet below mean low-water.

The approved project of 1878, modified in 1882, under which the work is now in progress, provides for a channel 25 feet deep and 300 feet wide, suitable for large ocean vessels, extending from Fox Point, in the city of Providence, to the deep water of Narragansett Bay, and for an anchorage basin between Fox and Field's points, 300 feet wide, at a depth of 25 feet; 600 feet wide, at a depth of 20 feet; 725 feet wide, at a depth of 18 feet; 940 feet wide, at a depth of 12 feet; 1,060 feet wide, at a depth of 6 feet.

The amount expended on the present project up to the close of the fiscal year ending June 30, 1889, including liabilities outstanding at that date, was $246,883.36. At that date the 25-foot channel 300 feet wide had been completed. Bulkhead Rock had been removed. The excavation of the 20-foot anchorage area had been completed in Fox Point Reach, and of the same areas in the Sassafras Point and the Field's Point reaches about one-fourth and one-half respectively had been done.

At the beginning of the last fiscal year no work was in progress. Dredging was commenced, with hired plant, in August, 1889, and continued until November 9. Dredging was also carried on in December, 1889, and January and February, 1890—the work of December being done with a dredge owned by the United States. During the fiscal year 96,034 cubic yards of mud were excavated.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1890, was $36,717.27, and the result was the completion of the 20-foot anchorage area on the east side of the Sassafras Point Reach, and 18-foot area on the east side of the Fox Point Reach, and about three-fourths of the 18-foot area on the same side of the Sassafras Point Reach, and the purchase of plant to the value of $18,326.53.

There is required for the completion of the existing project the excavation of the remainder of the anchorage basin between Fox and Field's Points.

July 1, 1889, amount available		$36,717.27
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$35,829.71	
July 1, 1890, outstanding liabilities	887.56	
		36,717.27
Amount appropriated by act of September 19, 1890		50,000.00
Amount (estimated) required for completion of existing project ..... Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		115,000.00

(See Appendix C 9.)

10. *Removal of Green Jacket Shoal, Providence River, Rhode Island.*—This shoal is in that part of Providence River which constitutes the harbor of Providence. It lies off the wharves, on the south front of the city, and occupies a part of the harbor that is required for anchorage purposes, covering an area of about 18 acres between the 15-foot curves.

The adopted project is the removal of the entire shoal to a depth of 25 feet at mean low water, limiting the work by lines drawn 200 feet from the harbor lines.

The amount expended, including outstanding liabilities to June 30, 1889, was $28,064.37, and the result was the excavation of an area of about 9¼ acres on the western side of the shoal to a depth of 25 feet at mean low water, making an important addition to the anchorage facilities of Providence Harbor.

At the beginning of the last fiscal year no work was in progress. Dredging was commenced with hired plant in August, 1889, and continued until November 9. From January 6 to February 8, 1890, the work was prosecuted with a dredge owned by the United States. The amount of material excavated was 147,520 cubic yards of mud and oyster shells.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1890, was $26,185.63, and the result was the en-

largement of the anchorage area by about 4½ acres and the purchase of plant to the value of $7,177.04.

July 1, 1889, amount available		$26,185.63
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$26,162.13	
July 1, 1890, outstanding liabilities	23.50	
		26,185.63
Amount appropriated by act of September 19, 1890		25,000.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		33,096.00

(See Appendix C 10.)

11. *Newport Harbor, Rhode Island.*—Before improvement the capacity of the inner harbor was limited by shoals, and it was not adequate to the number and size of the vessels seeking it for refuge. The southern or main entrance was obstructed by a bar which stretched out from Goat Island, and the general business wharves of the city could not be reached at low tide by vessels drawing more than 8 feet.

The original project and its subsequent modification, under which work is now carried on, are substantially as follows:

Deepening the southern entrance to 15 feet at mean low water and widening it by dredging Goat Island Spit northward to a line drawn from the dolphin which marks the spit, to clear the permanent dock at Fort Adams by 100 feet; the excavation of a channel 750 feet wide and 15 feet deep at mean low water around and to the eastward of this dolphin; deepening to 13 feet at mean low water the area included between the 13-foot curve on the west, a line drawn from the southwest corner of Perry Mill Wharf to Lime Rock on the south, the harbor line on the east, and a line drawn parallel to and 50 feet from the city wharf on the north; deepening to 10 feet at mean low water the area northwest of a line drawn from Lime Rock through the spindle which is in the southeast part of the harbor, and excavating a channel 10 feet deep at mean low water along and outside the harbor line south to a point opposite the gas company's wharf; and the construction of jetties on the western shore of Goat Island to arrest the drift of littoral sand and gravel into the entrance of the harbor.

The amount expended up to the close of the fiscal year ending June 30, 1889, was $159,489.21, with the following results:

Of the area to be dredged to 13 feet within the harbor, about nine-tenths had been completed. The channel along, and outside the harbor line south to a point opposite the gas company's wharf and the 15-foot channel, 750 feet wide, around and to the eastward of the Dolphin on Goat Island Spit, had been completed, with the exception of a narrow strip along the western edge and to the north of the dolphin. The increase of width to be made between the 15-foot curves at the southern entrance by dredging in the spit south of Goat Island had been completed. The berth for vessels at the quartermaster's wharf at Fort Adams had been deepened to 10 feet at mean low water, and the littoral sand from the outside of Goat Island had been stopped for the present from washing into the channel at the southern entrance of the harbor by the construction of a jetty on the west side of the island. The southern entrance is completed for vessels of 15 feet draught, and of the total area to be dredged within the harbor (about 90 acres) about two-thirds have been completed.

At the beginning of the last fiscal year no work was in progress.

ing done on the bars below Hartford until 1883. In 1873 a project for the construction of three jetties on Saybrook Bar was adopted; two of these have been built, the third will probably not be required. In 1880 a project for permanent improvement of six of the worst bars between Hartford and Middletown was adopted; it contemplated building rip-rap wing-dams, rectifying the banks, and protecting the caving banks by mattresses, at a total estimated cost of $330,487. It was afterwards found necessary to extend the project to include annual dredging at these and other bars and the extension and repair of the Saybrook jetties. Two of the contemplated permanent works have been built, a training-wall at Hartford Bar and a wing-dam at Glastonbury Bar, their total cost being $40,715.34. In addition to the work included in the estimate of $330,487, the east and west jetties at Saybrook have been extended and repaired and a channel 130 feet wide and 12 feet deep has been dredged between them, and from $5,000 to $10,000 have been annually expended in dredging to maintain a depth of 9 feet on the bars between Hartford and Saybrook.

Experience has shown that, on account of the frequency and height of freshets in this river, the permanent works projected in 1880 would be inadequate to maintain the desired depth, or even to materially reduce the amount of dredging annually required. Therefore, in December, 1887, a new project was adopted confining future operations to the completion of the Saybrook jetties to a height of 5 feet above high water, with a top width of 6 feet, and widening the channel between the jetties to 400 feet, with a depth of 12 feet at mean low water, at an estimated cost of $80,000, with annual dredging to maintain a 9-foot channel between Hartford and Long Island Sound, at an average cost of $10,000 per year.

An extension of the project to include raising the Hartford Dike to about 15 feet above low-water level is proposed, the estimated cost of which is $50,000, making the total estimate for completion $130,000; the reasons for this modification are given in detail in the appendix to this report.

It is believed that the effect of raising the dike will be to considerably reduce the cost of annual maintenance by dredging, and cause less interference with navigation by the occupation of the low-water channel by the dredging plant. Moreover, the revised estimate of $80,000, submitted for completion in 1888, was a reduction in the estimate of works previously proposed of about $290,000.

During the past fiscal year a navigable channel of 9 feet depth at low water was made, and, as far as practicable with available funds, maintained in the river below Hartford.

Future appropriations will be applied to maintenance of such a channel, to raising the Hartford Dike and completing the Saybrook jetties, and to widening the channel through Saybrook Bar.

July 1, 1889, amount available		$4,255.68
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$3,739.26	
July 1, 1890, outstanding liabilities	499.92	
		4,239.18
July 1, 1890, balance available		16.50
Amount appropriated by act of September 19, 1890		12,500.00
Amount available for fiscal year ending June 30, 1891		12,516.50
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		117,500.00

(See Appendix D 3.)

forming the eastern side of the inner harbor. The filling in the gap in the main breakwater had been carried to an extent sufficient to keep out the sea, which was formerly driven through it into the outer harbor in easterly storms.

The timber jetty, filled with stone, forming the shore end of the western wall of the enlarged inner harbor, and about 160 feet of its north wall, had been finished, and about 90 feet of the wall west of the opening into the harbor had been built to the level of mean high water.

At the beginning of the last fiscal year no work was in progress. Work was resumed on the north wall of the enlarged inner harbor August 3, 1889, and 1,941 tons of riprap granite were placed in it, and 420 tons on the breakwater, during the last fiscal year. Of the stone delivered, 1,265 tons were taken from Mason's Island Quarry, which is operated by the Government. November 18, 1889, the United States dredge, *Rhode Island*, commenced dredging in the enlarged inner harbor on the bar that had formed on the western side of the breakwater.

The dredging extended from the end of the steam-boat wharf to within about 100 feet of the north wall. Three thousand twenty-five yards of sand were dredged, making a depth of 9 feet at mean low water. The dredging was discontinued on December 28, 1889.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1890, was $13,194.20, and the result was the extension of the north wall of the enlarged inner harbor 50 feet to the westward, and the use of 420 tons of stone in the proposed repairs to the breakwater, and deepening the water to 9 feet on that part of the bar within the enlarged inner harbor that lies between the steam-boat wharf and a line 100 feet from the north wall. Also the purchase of plant to the value of $4,201.48.

July 1, 1889, amount available		$13,854.12
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$11,682.64	
July 1, 1890, outstanding liabilities	1,511.56	
		13,194.20
July 1, 1890, balance available		659.92
Amount appropriated by act of September 19, 1890		15,000.00
Amount available for fiscal year ending June 30, 1891		15,659.92
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		24,000.00

(See Appendix C 12.)

13. *Pawcatuck River, Rhode Island and Connecticut.*—The navigable part of the Pawcatuck River extends from the town of Westerly to Little Narragansett Bay, and the object of the improvement is to deepen and widen the channel leading from this bay to Westerly.

Before improvement, the channel was crooked and obstructed by numerous shoals, on some of which there was but 1¼ feet of water at mean low water.

By appropriations made in the years 1871 to 1875 the river was improved by the excavation of a channel 5½ feet deep at mean low water and 75 feet wide below the wharves and from 35 to 40 feet wide between the upper and lower wharves. The present project contemplates the further widening of the channel to 100 feet below the wharves and by an additional width of two cuts of an ordinary dredging-machine, or about 40 feet, between the lower and upper wharves; also the deepening of the entire channel to 8 feet at mean low water.

Ledge to Quixe's Ledge; the second to be 4,200 feet long, extending northwesterly from Luddington Rock. The estimated cost was $1,311,134. No modification of the project has been adopted except slight changes of cross-section in 1880.

During the past fiscal year $7,764.83 have been expended in extending the east breakwater 280 feet and in enlarging its cross-section; this breakwater is completed. It is 3,450 feet long, and extends from Southwest Ledge to and across Quixe's Ledge.

The west breakwater is not begun.

The river and harbor act of August 11, 1888, provided, "And the Chief of Engineers may, if deemed necessary, relocate the western breakwater, and the Secretary of War is authorized in his discretion to expend any portion of said sum in commencing its construction." The New Haven harbor-commissioners proposed a plan for relocation of the western breakwater which would largely increase the anchorage afforded under the original project, and which would cost about $5,000,000. There is no doubt of the desirability of increasing the anchorage-ground, but the expenditure required by this plan is larger than the present demands of commerce seem to warrant. A plan was suggested by the officer in charge for changing the location of the western breakwater to the southwest about 6,000 feet, and constructing a breakwater 5,000 feet long, which should start at a point 1,000 feet N. 54° E. from Luddington Rock, and extend S. 54° W., crossing the rock. The cost of this, in addition to the present estimates of $1,311,134, would be about $750,000. Further details concerning this plan and a sketch showing location of proposed works are printed in the Annual Report for 1889, Part I, pages 60 and 61; also Appendix D 6, pages 675–685.

July 1, 1889, amount available		$23,435.31
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$7,764.83	
July 1, 1890, outstanding liabilities	175.00	
		7,939.83
July 1, 1890, balance available		15,495.48
Amount appropriated by act of September 19, 1890		120,000.00
Amount available for fiscal year ending June 30, 1891		135,495.48
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		821,134.00

(See Appendix D 6.)

7. *Milford Harbor, Connecticut.*—This harbor consists of a broad open bay, from the head of which a small tidal stream extends three-quarters of a mile inland to the upper wharf. Originally the depth on the bar at the mouth of the river was less than 2 feet at mean low tide; in parts of the river the channel ran nearly bare.

Under the first project for improvement, adopted in 1872, a channel 4 feet deep and 100 feet wide was excavated through the bar, and thence 40 to 60 feet wide to the upper wharf; small jetties were built to protect the east bank from erosion, and two jetties were built to preserve the channel on the bar, at a total cost of $34,000. In 1881 a project was adopted for making the channel through the bar 8 feet deep at mean low water and 100 feet wide, at an estimated cost of $11,000.

The 8-foot channel has been completed to 100 feet width.

Nothing was done during the past fiscal year.

The project is completed.

of the eastern breakwater to a point about 2,290 feet from its eastern extremity.

The work required is to finish the construction of the eastern breakwater. In case it be found that sufficient protection to the harbor of refuge has been afforded when the range from Stonington Light to the middle of Wicopessit Island is reached, the length of the breakwater yet to be built will be about 280 feet. Should it be decided to extend it to the Middle Ground it will require about 100 feet more.

The completion of this work will afford a thoroughly protected anchorage for vessels drawing 18 feet of water and a harbor of refuge for the commerce which daily passes between Long Island Sound and the eastward.

July 1, 1889, amount available		$912.84
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$775.15	
July 1, 1890, outstanding liabilities	87.42	
		862.57
July 1, 1890, balance available		50.27
Amount appropriated by act of September 19, 1890		12,500.00
Amount available for fiscal year ending June 30, 1891		12,550.27
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		12,500.00

(See Appendix C 14.)

15. *Removing sunken vessels or craft obstructing or endangering navigation.—Wreck of schooner Sarah L. Simmons.*—This vessel was wrecked September 11, 1889, about 700 yards from Pollock Rip lightship. A contract for its removal was made and the work finally completed March 31, 1890. Much delay was caused by unfavorable weather.

Wreck of schooner Ellen R., in Little Harbor, Wood's Holl, Massachusetts. A contract for the removal of this wreck was entered into and the work was completed March 26, 1890.

Wreck of schooner Quilp, on the north side of the entrance to Cuttyhunk Pond, Cuttyhunk Island, Massachusetts. A contract for the removal of this wreck was entered into and the work was completed March 24, 1890.

Wreck of schooner Benjamin Gartside.—This vessel was sunk by collision October 5, 1889, while lying at anchor about 2½ miles from Handkerchief light-ship. She was loaded with a cargo of coal. A contract for removal of the wreck was made and work was commenced June 18, 1890.

(See Appendix C 15.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENT TO COMPLY WITH REQUIREMENTS OF RIVER AND HARBOR ACT OF AUGUST 11, 1888.

It appearing from the preliminary examination made by the local engineer that the following localities are worthy of improvement, and the public necessity therefor being apparent from the facts and reasons reported, which are concurred in by the Chief of Engineers, Major Livermore was charged with and completed their survey, the results of which were transmitted to Congress and printed in Ex. Docs. of the Fifty-first Congress, first session:

1. *Martha's Vineyard, inner and outer harbor at Edgartown, Massachusetts.*—Printed as House Ex. Doc. 59. (See also Appendix C 16.)

to the head of the upper harbor, above the bridges; the total estimated cost of these extensions was $35,000. In addition to this a further extension has been asked by the citizens to provide for a breakwater from the Tongue to the Inner Beacon, estimated to cost $30,000.

During the past fiscal year the available funds were expended in dredging in the upper harbor above the bridges.

July 1, 1889, amount available		$2,438.87
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889		1,110.12
July 1, 1890, balance available		1,328.75
Amount appropriated by act of September 19, 1890		20,000.00
Amount available for fiscal year ending June 30, 1891		21,328.75
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		35,000.00

(See Appendix D 9.)

10. *Black Rock Harbor, Connecticut.*—This harbor consists of a bay partly sheltered by Fairweather Island, and of two small streams extending inland from the head of the bay. The depth in Cedar Creek, the more important of these streams, was from 2 to 4 feet at mean low water, and the channel was narrow and very crooked.

The project for improvement, submitted in 1883, includes dredging a channel 3,300 feet long, 80 feet wide, and 6 feet deep, to extend up Cedar Creek, and a breakwater from Fairweather Island to the mainland. The estimated cost was $80,000.

The breakwater has been built to the full length, but not to the width and height projected. The proposed channel has been carried up to the head of the harbor, with rather less than the projected width in places.

During the past fiscal year the channel was extended about 2,200 feet.

July 1, 1889, amount available		$2,084.56
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$748.13	
July 1, 1890, outstanding liabilities	875.00	
		1,623.13
July 1, 1890, balance available		461.43
Amount appropriated by act of September 19, 1890		5,000.00
Amount available for fiscal year ending June 30, 1891		5,461.43
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		40,000.00

(See Appendix D 10.)

11. *Norwalk Harbor, Connecticut.*—This harbor consists of the tidal part of Norwalk River extending from Norwalk, Conn., to the river's mouth, a distance of about 3 miles, and of an outer harbor lying between Norwalk Island and the mainland. South Norwalk is on the river about 1½ miles below Norwalk. Originally the depth up to South Norwalk was about 5 feet at mean low water; between there and Norwalk the river-bed ran nearly bare.

The first project for improvement contemplated a channel 100 feet wide and 6 feet deep to Norwalk. In 1881 the project was modified to provide for a depth of 8 feet below South Norwalk. The last estimate upon this work placed the cost from commencement at $84,000.

The project for improvement adopted in 1880 and slightly modified in 1882 provided for removing to a depth of 16 feet at mean low water the southerly part of a shoal of sand and bowlders lying east of the New London Northern Railroad Wharf. The original depth on this part of the shoal was from 5 to 15 feet.

Nineteen thousand eight hundred dollars have been appropriated for and expended on this work.

Nothing was done during the past fiscal year.

The required depth has been made over nearly the whole area contemplated in the project, which is regarded as completed, no further work under it being desired.

July 1, 1889, amount available	$201.39
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	201.39

(See Appendix D 2.)

3. *Connecticut River, Massachusetts and Connecticut—above Hartford.*—From Holyoke, Mass., 34 miles above Hartford, down to Enfield Falls or Rapids a distance of 18 miles, there is a fair channel 4 to 5 feet deep. Enfield Rapids extends about 5 miles over a rocky and uneven bed, with a total fall of 32 feet. From the foot of Enfield Rapids to Hartford, a distance of 11 miles, the river-bed is broad and sandy, with a channel from 2 to 5 feet deep at low water. Several years ago the Connecticut River Company constructed a small canal around Enfield Rapids, through which boats of 3 feet draught and 80 feet length can pass.

The several projects under which work has been done have been for dredging at Barber's Landing and for wing dams. In 1878 plans and estimates were submitted for construction of a canal 8 feet deep around Enfield Rapids; these estimates were revised in 1880. The estimated cost of the canal was $1,322,805; it was not considered advisable to commence construction with a less sum than $450,000, which has not yet been appropriated.

Up to the close of the present fiscal year $100,000 have been appropriated for this part of the river, of which $91,059.70 have been expended.

All the work done has been dredging and the construction and repair of seven wing dams.

No work was done during the past fiscal year.

The funds on hand from previous appropriations are sufficient for such repairs and temporary improvement as may be needed during the ensuing fiscal year.

July 1, 1889, amount available	$9,133.20
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	192.90
July 1, 1890, balance available	8,940.30

Connecticut River, below Hartford.—Between Hartford and Long Island Sound, a distance of 50 miles by course of channel, the depth on the bars was formerly 5 feet at low water, the worst places being between Hartford and Middletown, a distance of 19 miles, and at Saybrook Bar, at the mouth of the river. Dredging was carried on and small wing-dams were constructed by private parties and by a State corporation up to 1868 with no permanent benefit.

In 1868 a project for improvement by the United States was submitted, under which a pile-dike was built at Hartford and annual dredg-

of the river at mean low water was from 1 to 3 feet, gradually increasing in the bay to a depth of 12 feet.

The project for improvement, proposed in 1883 and adopted in 1886, provides for dredging a channel 80 feet wide and 5 feet deep at mean low water from the bay to the head of the harbor, at an estimated cost of $20,000.

Fifteen thousand dollars have been expended in making a channel 5 feet deep, with width of 80 feet or over for more than half its projected length and 50 feet for the rest of the distance.

Nothing was done during the past fiscal year.

July 1, 1889, amount available	$630.34
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	116.48
July 1, 1890, balance available	513.86
Amount appropriated by act of September 19, 1890	5,000.00
Amount available for fiscal year ending June 30, 1891	5,513.86

(See Appendix D 13.)

14. *Port Chester Harbor, New York.*—This harbor consists of a bay opening into Long Island Sound at the mouth of Byram River, and of the lower part of the river itself, which is navigable for about a mile above its mouth.

The original available depth in the river was not more than a foot at low water, and Salt Rock in the river, and Sunken Rock in the bay, were considered dangerous obstructions.

The project for improvement, adopted in 1871, provided for the removal of these rocks to 9 and 11 feet depth respectively, and for the construction of a breakwater at Byram Point, at the mouth of the harbor, the estimated cost being $96,632.

In 1881 the project was extended to provide for dredging a channel 2½ feet deep and from 60 to 100 feet wide, from the bay to the vicinity of the village wharves.

In 1888 the project was further modified to omit the removal of Sunken Rock, and to build a breakwater from that rock to Byram Point, which should also serve as a beacon on the rock.

Salt Rock has been removed to the required depth of 9 feet at mean low water, a channel 2½ feet deep and from 60 to 100 feet wide has been completed to within 150 feet of the Port Chester Bridge, with 25 feet width to the bridge, and 288 linear feet of the breakwater from Sunken Rock towards Byram Point have been built.

Nothing was done during the past fiscal year.

A revised estimate, made in 1890 in accordance with the modification of 1888, places the cost of completion of the project at $20,000, instead of $64,632, as under the original project.

July 1, 1889, amount available	$14.71
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	3.50
July 1, 1890, balance available	11.21
Amount appropriated by act of September 19, 1890	5,000.00
Amount available for fiscal year ending June 30, 1891	5,011.21
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	20,000.00

(See Appendix D 14.)

4. *Clinton Harbor, Connecticut.*—This harbor is 10 miles west of the mouth of the Connecticut River. Its channel runs for nearly a mile inside of a beach, through which a breach was made about the year 1840, after which the channel shoaled in two places to about 4 feet depth where it had been 8 feet deep.

The project for improvement adopted in 1882 provided for closing the breach and, if that did not restore the channel depth, for dredging a channel 100 feet wide and 6 feet deep at mean low water through the shoals. The entire cost was estimated at $10,000.

A riprap dike was built across the breach in 1883; it requires some repair. The channel depth has not changed since 1882.

Nothing was done during the past fiscal year.

July 1, 1889, amount available	$252.73
July 1, 1890, balance available	252.73
Amount appropriated by act of September 19, 1890	3,500.00
Amount available for fiscal year ending June 30, 1891	3,752.73
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	3,500.00

(See Appendix D 4.)

5. *New Haven Harbor, Connecticut.*—The original available low-water depth up to the wharves in this harbor was about 9 feet.

The first project for deepening the channel provided for making it 13 feet deep, which was done in 1871. It was widened at different times until 1878, when a project was adopted for dredging a channel 16 feet deep and not less than 400 feet wide. In 1882 a project was adopted for building a dike to extend out from Sandy Point, with an arm parallel to the channel and 3,200 feet long, in order to contract the channel and maintain 16 feet depth on Fort Hale Bar when that depth should be obtained by dredging.

A 16-foot channel, from 400 to 600 feet wide, has been obtained all the way up the harbor, except over the Fort Hale Bar, where the depth is but 13 feet.

The shore-arm and 2,089 feet of the channel-arm of the Sandy Point Dike have been built.

During the past fiscal year the Sandy Point Dike was extended 320 feet, and shoals were removed from the side of the channel near the head of the harbor.

July 1, 1889, amount available	$1,159.88
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	989.24
July 1, 1890, balance available	170.64
Amount appropriated by act of September 19, 1890	15,000.00
Amount available for fiscal year ending June 30, 1891	15,170.64
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	63,000.00

(See Appendix D 5.)

6. *Breakwater at New Haven, Connecticut.*—In 1880 a project was adopted for making a harbor of refuge at the entrance to New Haven Harbor by the construction of two riprap breakwaters; the first to be 3,300 feet long, extending northeasterly from the light-house on Southwest

The channel has been made 9 feet deep at high water and 125 feet wide to the head of Goose Island, one-half mile from the mouth of the creek; thence to Town Dock 100 feet wide, and thence to Lockwood's nearly the same width. Above Town Dock 1,235 linear feet of diking have been built on the east side of the channel.

Nothing was done during the past fiscal year.

A lay-out for the channel above Lockwood's was surveyed in 1889, and an unsuccessful effort was made to obtain consent of owners to the depositing of material to be dredged upon the adjacent marsh lands. Without this consent dredging would be very expensive, and the officer in charge considers it inexpedient to begin work until at least $25,000 is available.

The funds remaining are sufficient for all present needs below Lockwood's. Unless it is considered advisable to extend the improvement above Lockwood's, no additional funds are now needed. There is at present no navigation above that point, and it is doubtful whether there will be to any great extent should the proposed improvement be made.

July 1, 1889, amount available	$7,163.08
July 1, 1890, amount expended during the fiscal year, exclusive of liabilities outstanding July 1, 1889	22.05
July 1, 1890, balance available	7,141.03
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	152,100.00

(See Appendix D 17.)

18. *Greenport Harbor, New York.*—This harbor, at the eastern end of Long Island, is exposed to easterly storms. Its anchorage ground, which was sheltered by Joshua's Point, has materially shoaled by the erosion of the point and by the influx of drifting sand.

The project for improvement, adopted in 1882, provided for the construction of a riprap breakwater extending from Joshua's Point 1,700 feet in a southeasterly course to arrest drifting sand, to check the erosion of the point, and to increase the sheltered area. Its cost was estimated at $46,000.

During the past fiscal year the available funds were expended in extending the breakwater 35 linear feet; its present length is 1,570 feet.

July 1, 1889, amount available	$131.23
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	131.23
Amount appropriated by act of September 19, 1890	5,000.00
Amount (estimated) required for completion of existing project. Submitted on compliance with requirements of sections 2 of the river and harbor acts of 1866 and 1867.	11,000.00

(See Appendix D 18.)

19. *Glen Cove Harbor, New York.*—This harbor is an inlet on the east side of Hempstead Bay, which is accessible only at high tide, and a breakwater was needed to shelter vessels while at anchor waiting for tides.

The project for improvement, adopted in 1888, provides for a riprap breakwater about 2,500 feet long, extending in a west-southwesterly direction from the northwest corner of the Glen Cove Dock; its estimated cost is $201,960.

July 1, 1889, amount available		$1,404.35
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889		1,332.40
July 1, 1890, balance available		71.95
Amount appropriated by act of September 19, 1890		2,500.00
Amount available for fiscal year ending June 30, 1891		2,571.95
Amount (estimated) required for repairs. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		2,500.00

(See Appendix D 7.)

8. *Housatonic River, Connecticut.*—The navigable part of this river extends from Derby, Conn., to Long Island Sound, a distance of 13 miles, and was originally obstructed by several bars upon which the low-water depth was from 3 to 5 feet.

In 1871 a project was adopted for making and maintaining a channel 100 feet wide and 7 feet deep at mean low water throughout this distance. Besides the necessary dredging, it contemplated building a breakwater east of the channel over the bar at the river's mouth.

A channel of the required depth has been dredged several times through the worst bars; the present available depth over them is about 6 feet at mean low water. Drew's Rock has been removed to a depth of 7 feet.

During the past fiscal year dredging was done to maintain the channel through the bars in the river, and 1,200 linear feet of the breakwater at the river's mouth were built, under a contract still in progress.

July 1, 1889, amount available		$8,131.18
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$2,907.20	
July 1, 1890, outstanding liabilities	90.00	
		2,997.20
July 1, 1890, balance available		5,133.98
Amount appropriated by act of September 19, 1890		35,000.00
Amount available for fiscal year ending June 30, 1891		40,133.98
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		132,000.00

(See Appendix D 8.)

9. *Bridgeport Harbor, Connecticut.*—The available depth in this harbor was originally 5 feet at mean low water.

The first project for improvement provided for an 8 foot channel over the outer and inner bars. This was dredged on the outer bar in 1837, and on both bars in 1853. In 1871 a project was adopted for making a channel 12 feet deep and 100 feet wide, subsequently modified to 300 feet, and for building a jetty on the east shore to check the influx of sand. This was accomplished in 1882, and a new project was adopted for widening to 600 feet the channel from the Inner Beacon to the Naugatuck Railroad wharf, to provide for vessels driven in by bad weather, without blocking the main channel. The estimated cost of the latter project was $60,000; it is very nearly completed. A small area remains near the Inner Beacon which it is considered desirable to dredge. The project was extended in 1888 to include widening the channel above the railroad wharf in order to relieve the crowding at that point, and was further extended by act of Congress authorizing the expenditure of the appropriation of 1888 towards dredging a 9-foot channel up

Houston was charged with and completed their survey, the results of which were transmitted to Congress and printed in Ex. Doc's. of the Fifty-first Congress, first session.

1. *Brown's Creek, Sayville, New York.*—Printed as House Ex. Doc. 22. (See also Appendix D 22.)

2. *Larchmont Harbor, New York.*—Printed as House Ex. Doc. 40. (See also Appendix D 23.)

IMPROVEMENT OF HUDSON RIVER AND OF HARBORS OF RONDOUT AND SAUGERTIES, NEW YORK—REMOVING OBSTRUCTIONS IN EAST RIVER AND HELL GATE—IMPROVEMENT OF ENTRANCE TO NEW YORK HARBOR—IMPROVEMENT OF RIVERS AND HARBORS IN THE VICINITY OF NEW YORK AND IN NORTHERN NEW JERSEY.

Officer in charge, Lieut. Col. G. L. Gillespie, Corps of Engineers, having under his immediate orders Lieut. Harry Taylor, Corps of Engineers.

1. *Hudson River, New York.*—The improvement of this river has been restricted by the wording of the appropriation acts to that part of it lying between Troy, at the head of navigation, 6 miles above Albany, and New Baltimore, about 14 miles below Albany.

Before the improvement was begun the navigable depth in the channel between New Baltimore and Albany was 7½ feet at mean low water; between Albany and Troy, 4 feet.

The plan of improvement adopted in 1867 proposed making the navigable depth between New Baltimore and Albany 11 feet, and between Albany and Troy 9 feet. This was to be accomplished by the construction of longitudinal dikes to direct the currents, and by dredging.

The estimated cost of making this improvement, prepared in 1882, subject to be increased annually, was $1,078,304. In 1889 the estimated cost was $1,424,435.

The amount expended to June 30, 1889, inclusive of outstanding liabilities, was $1,033,739.59, of which sum a large part has, however, from the necessity of the case, been applied to the repair of decaying dikes instead of to the construction of the new dikes yet to be built. At that date the dikes provided for in the project of improvement, so far as built, have resulted in securing a channel depth of 10 feet nearly all the way from New Baltimore to Albany, and of 8 feet nearly all the way from Albany to Troy. The shoal spots make the navigable depths on those parts of the river 9½ feet and 7½ feet, respectively.

The amount expended during the fiscal year ending June 30, 1890, inclusive of outstanding liabilities, was $31,573.05, and was applied to the repairs of the dikes and to the construction of a new dike at Mull's Plaat.

July 1, 1889, amount available		$94,856.28
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$31,365.05	
July 1, 1890, outstanding liabilities	8,656.35	
July 1, 1890, amount covered by uncompleted contracts made during the fiscal year ending June 30, 1890	44,396.15	
		81,417.55
July 1, 1890, balance available		10,438.73
Amount appropriated by act of September 19, 1890		150,000.00
Amount available for fiscal year ending June 30, 1891		160,438.73
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867		145,000.00

(See Appendix E 1.)

July 1, 1889, amount available	$1,404.35
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,332.40
July 1, 1890, balance available	71.95
Amount appropriated by act of September 19, 1890	2,500.00
Amount available for fiscal year ending June 30, 1891	2,571.95
Amount (estimated) required for repairs. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	2,500.00

(See Appendix D 7.)

8. *Housatonic River, Connecticut.*—The navigable part of this river extends from Derby, Conn., to Long Island Sound, a distance of 13 miles, and was originally obstructed by several bars upon which the low-water depth was from 3 to 5 feet.

In 1871 a project was adopted for making and maintaining a channel 100 feet wide and 7 feet deep at mean low water throughout this distance. Besides the necessary dredging, it contemplated building a breakwater east of the channel over the bar at the river's mouth.

A channel of the required depth has been dredged several times through the worst bars; the present available depth over them is about 6 feet at mean low water. Drew's Rock has been removed to a depth of 7 feet.

During the past fiscal year dredging was done to maintain the channel through the bars in the river, and 1,200 linear feet of the breakwater at the river's mouth were built, under a contract still in progress.

July 1, 1889, amount available		$8,131.18
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$2,907.20	
July 1, 1890, outstanding liabilities	90.00	
		2,997.20
July 1, 1890, balance available		5,133.98
Amount appropriated by act of September 19, 1890		35,000.00
Amount available for fiscal year ending June 30, 1891		40,133.98
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		132,000.00

(See Appendix D 8.)

9. *Bridgeport Harbor, Connecticut.*—The available depth in this harbor was originally 5 feet at mean low water.

The first project for improvement provided for an 8 foot channel over the outer and inner bars. This was dredged on the outer bar in 1837, and on both bars in 1853. In 1871 a project was adopted for making a channel 12 feet deep and 100 feet wide, subsequently modified to 300 feet, and for building a jetty on the east shore to check the influx of sand. This was accomplished in 1882, and a new project was adopted for widening to 600 feet the channel from the Inner Beacon to the Naugatuck Railroad wharf, to provide for vessels driven in by bad weather, without blocking the main channel. The estimated cost of the latter project was $60,000; it is very nearly completed. A small area remains near the Inner Beacon which it is considered desirable to dredge. The project was extended in 1888 to include widening the channel above the railroad wharf in order to relieve the crowding at that point, and was further extended by act of Congress authorizing the expenditure of the appropriation of 1888 towards dredging a 9-foot channel up

to the head of the upper harbor, above the bridges; the total estimated cost of these extensions was $35,000. In addition to this a further extension has been asked by the citizens to provide for a breakwater from the Tongue to the Inner Beacon, estimated to cost $30,000.

During the past fiscal year the available funds were expended in dredging in the upper harbor above the bridges.

July 1, 1889, amount available	$2,438.87
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,110.12
July 1, 1890, balance available	1,328.75
Amount appropriated by act of September 19, 1890	20,000.00
Amount available for fiscal year ending June 30, 1891	21,328.75
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	35,000.00

(See Appendix D 9.)

10. *Black Rock Harbor, Connecticut.*—This harbor consists of a bay partly sheltered by Fairweather Island, and of two small streams extending inland from the head of the bay. The depth in Cedar Creek, the more important of these streams, was from 2 to 4 feet at mean low water, and the channel was narrow and very crooked.

The project for improvement, submitted in 1883, includes dredging a channel 3,300 feet long, 80 feet wide, and 6 feet deep, to extend up Cedar Creek, and a breakwater from Fairweather Island to the mainland. The estimated cost was $80,000.

The breakwater has been built to the full length, but not to the width and height projected. The proposed channel has been carried up to the head of the harbor, with rather less than the projected width in places.

During the past fiscal year the channel was extended about 2,200 feet.

July 1, 1889, amount available		$2,084.56
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$748.13	
July 1, 1890, outstanding liabilities	875.00	
		1,623.13
July 1, 1890, balance available		461.43
Amount appropriated by act of September 19, 1890		5,000.00
Amount available for fiscal year ending June 30, 1891		5,461.43
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		40,000.00

(See Appendix D 10.)

11. *Norwalk Harbor, Connecticut.*—This harbor consists of the tidal part of Norwalk River extending from Norwalk, Conn., to the river's mouth, a distance of about 3 miles, and of an outer harbor lying between Norwalk Island and the mainland. South Norwalk is on the river about 1½ miles below Norwalk. Originally the depth up to South Norwalk was about 5 feet at mean low water; between there and Norwalk the river-bed ran nearly bare.

The first project for improvement contemplated a channel 100 feet wide and 6 feet deep to Norwalk. In 1881 the project was modified to provide for a depth of 8 feet below South Norwalk. The last estimate upon this work placed the cost from commencement at $84,000.

Some parts of the river have required dredging several times.

A channel has been dredged 100 feet wide and 8 feet deep up to South Norwalk, and thence to Norwalk from 60 to 100 feet wide and 6 feet deep. This channel is now in fair condition.

The river and harbor act of August 11, 1888, appropriated $28,000 for improvement of the harbor and provided that $25,000 should be expended in dredging and deepening the lower harbor up to Wilson's Point. The estimated cost of the latter work was $52,900.

During the past fiscal year the contract for dredging at Wilson's Point was completed. The channel is now about 400 feet wide and 15 feet deep at mean low water up to within 300 feet of the railroad docks; close to the docks the dredging was done by the railroad company, and the depth made was from 12 to 15 feet.

Owing to the low price obtained for this dredging, and to the fact that a large part of the work contemplated under the estimate had been done by the railroad company, the desired channel has been completed with the appropriation already made, and no further appropriation for this point is needed.

July 1, 1889, amount available		$9,839.48
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$8,788.36	
July 1, 1890, outstanding liabilities	91.50	
		8,879.86
July 1, 1890, balance available		959.62
Amount appropriated by act of September 19, 1890		4,000.00
Amount available for fiscal year ending June 30, 1891		4,959.62

(See Appendix D 11.)

12. *Harbor at Five Mile River, Connecticut.*—This harbor is a small inlet, over a mile long and from 300 to 800 feet wide, on the north shore of Long Island Sound. The natural low-water depth at the mouth is about 3 feet, shoaling to zero half-way up the harbor.

The project for improvement proposed in a report on a survey made in 1886, and adopted under an appropriation of $5,000 made August 11, 1888, provides for dredging a channel 8 feet deep at mean low water 100 feet wide and about 6,000 feet long, extending to the head of the harbor; the cost was estimated at $25,000.

During the past fiscal year the available funds were expended in extending the dredged channel 750 feet further up the harbor, making it 1,500 feet long and 50 feet wide.

July 1, 1889, amount available	$2,756.97
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	2,577.72
July 1, 1890, balance available	179.25
Amount appropriated by act of September 19, 1890	5,000.00
Amount available for fiscal year ending June 30, 1891	5,179.25
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	15,000.00

(See Appendix D 12.)

13. *Stamford Harbor, Connecticut.*—This harbor consists of a bay on the north shore of Long Island Sound and of the tidal part about three-quarters of a mile long of Mill River. The original depth in this part

of the river at mean low water was from 1 to 3 feet, gradually increasing in the bay to a depth of 12 feet.

The project for improvement, proposed in 1883 and adopted in 1886, provides for dredging a channel 80 feet wide and 5 feet deep at mean low water from the bay to the head of the harbor, at an estimated cost of $20,000.

Fifteen thousand dollars have been expended in making a channel 5 feet deep, with width of 80 feet or over for more than half its projected length and 50 feet for the rest of the distance.

Nothing was done during the past fiscal year.

July 1, 1889, amount available	$630.34
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	116.48
July 1, 1890, balance available	513.86
Amount appropriated by act of September 19, 1890	5,000.00
Amount available for fiscal year ending June 30, 1891	5,513.86

(See Appendix D 13.)

14. *Port Chester Harbor, New York.*—This harbor consists of a bay opening into Long Island Sound at the mouth of Byram River, and of the lower part of the river itself, which is navigable for about a mile above its mouth.

The original available depth in the river was not more than a foot at low water, and Salt Rock in the river, and Sunken Rock in the bay, were considered dangerous obstructions.

The project for improvement, adopted in 1871, provided for the removal of these rocks to 9 and 11 feet depth respectively, and for the construction of a breakwater at Byram Point, at the mouth of the harbor, the estimated cost being $96,632.

In 1881 the project was extended to provide for dredging a channel 2½ feet deep and from 60 to 100 feet wide, from the bay to the vicinity of the village wharves.

In 1888 the project was further modified to omit the removal of Sunken Rock, and to build a breakwater from that rock to Byram Point, which should also serve as a beacon on the rock.

Salt Rock has been removed to the required depth of 9 feet at mean low water, a channel 2½ feet deep and from 60 to 100 feet wide has been completed to within 150 feet of the Port Chester Bridge, with 25 feet width to the bridge, and 288 linear feet of the breakwater from Sunken Rock towards Byram Point have been built.

Nothing was done during the past fiscal year.

A revised estimate, made in 1890 in accordance with the modification of 1888, places the cost of completion of the project at $20,000, instead of $64,632, as under the original project.

July 1, 1889, amount available	$14.71
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	3.50
July 1, 1890, balance available	11.21
Amount appropriated by act of September 19, 1890	5,000.00
Amount available for fiscal year ending June 30, 1891	5,011.21
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	20,000.00

(See Appendix D 14.)

15. *Echo Harbor, New Rochelle, New York.*—The channel of this harbor was obstructed by two ledges, Start Rock and Sheepshead Reef, the former bare at low water, the latter covered to a depth of about a foot.

The project for improvement adopted in 1875 provided for the removal of these rocks to 7 and 9 feet depths, respectively. The estimated cost was $38,955.38.

Twenty-two thousand dollars have been appropriated for this harbor, and nearly all expended. Start Rock has been wholly removed to 7 feet depth, and Sheepshead Reef partly removed to 9 feet depth; a narrow channel has also been dredged up the harbor.

During the past fiscal year the available money was expended in dredging a channel 40 feet wide and 4 feet deep at mean low water, extending about 1,050 feet to within about 300 feet of the head of the harbor.

July 1, 1889, amount available	$3,043.97
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	3,043.97
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	17,000.00

(See Appendix D 15.)

16. *New Rochelle Harbor, New York.*—This harbor consists mainly of a rather narrow and crooked channel lying between rocky islands.

The project for improvement adopted in 1881 provided for the removal of two rocks and for dredging and removing a reef to secure a channel 8 feet deep and 100 feet wide between Hunter's and Glen Islands. The estimated cost was $40,825.

Thirty-five thousand dollars have been appropriated and nearly all expended for this project. The channel around Glen Island has been made 8 feet deep and 100 feet wide, and the reef has been removed to 7½ feet depth; one of the rocks, Corning Rock, has been removed to the required depth of 12 feet; upon the other, Rock "C," no work has been done.

During the past fiscal year the channel between Hunter's and Glen Islands was dredged 8 feet deep and 100 feet wide.

There is no immediate need for further work under this project, the removal of Rock "C" not being contemplated at present.

July 1, 1889, amount available	$9,026.70
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	8,806.77
July 1, 1890, balance available	219.93

(See Appendix D 16.)

17. *East Chester Creek, New York.*—This is a small tidal stream emptying into Pelham Bay. It was navigable at high tide only, for vessels drawing 7 feet, up to Lockwood's, a distance of 2¼ miles. The rise of tide is 7.1 feet.

The project for improvement adopted in 1872 and subsequently modified provided for a channel 9 feet deep at mean high water, extending to a point 3,000 feet above Lockwood's and terminating at the upper end in a tidal basin. A revised estimate of the cost of the project as modified is placed by the officer in charge at $221,000.

Sixty-four thousand dollars have been appropriated for this improvement.

The channel has been made 9 feet deep at high water and 125 feet wide to the head of Goose Island, one-half mile from the mouth of the creek; thence to Town Dock 100 feet wide, and thence to Lockwood's nearly the same width. Above Town Dock 1,235 linear feet of diking have been built on the east side of the channel.

Nothing was done during the past fiscal year.

A lay-out for the channel above Lockwood's was surveyed in 1889, and an unsuccessful effort was made to obtain consent of owners to the depositing of material to be dredged upon the adjacent marsh lands. Without this consent dredging would be very expensive, and the officer in charge considers it inexpedient to begin work until at least $25,000 is available.

The funds remaining are sufficient for all present needs below Lockwood's. Unless it is considered advisable to extend the improvement above Lockwood's, no additional funds are now needed. There is at present no navigation above that point, and it is doubtful whether there will be to any great extent should the proposed improvement be made.

July 1, 1889, amount available	$7,163.08
July 1, 1890, amount expended during the fiscal year, exclusive of liabilities outstanding July 1, 1889	22.05
July 1, 1890, balance available	7,141.03
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	152,100.00

(See Appendix D 17.)

18. *Greenport Harbor, New York.*—This harbor, at the eastern end of Long Island, is exposed to easterly storms. Its anchorage ground, which was sheltered by Joshua's Point, has materially shoaled by the erosion of the point and by the influx of drifting sand.

The project for improvement, adopted in 1882, provided for the construction of a riprap breakwater extending from Joshua's Point 1,700 feet in a southeasterly course to arrest drifting sand, to check the erosion of the point, and to increase the sheltered area. Its cost was estimated at $46,000.

During the past fiscal year the available funds were expended in extending the breakwater 35 linear feet; its present length is 1,570 feet.

July 1, 1889, amount available	$131.23
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	131.23
Amount appropriated by act of September 19, 1890	5,000.00
Amount (estimated) required for completion of existing project. Submitted on compliance with requirements of sections 2 of the river and harbor acts of 1866 and 1867.	11,000.00

(See Appendix D 18.)

19. *Glen Cove Harbor, New York.*—This harbor is an inlet on the east side of Hempstead Bay, which is accessible only at high tide, and a breakwater was needed to shelter vessels while at anchor waiting for tides.

The project for improvement, adopted in 1888, provides for a riprap breakwater about 2,500 feet long, extending in a west-southwesterly direction from the northwest corner of the Glen Cove Dock; its estimated cost is $201,960.

During the past fiscal year the available funds were expended in extending the breakwater 545 linear feet; it is now 765 feet long, but it is not built up to the full height and width projected.

July 1, 1889, amount available	$8,118.14
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	8,008.52
July 1, 1890, balance available	109.62
Amount appropriated by act of September 19, 1890	15,000.00
Amount available for fiscal year ending June 30, 1891	15,109.62
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	166,960.00

(See Appendix D 19.)

20. *Flushing Bay, New York.*—Before improvement the available depth in this broad, shallow bay and in the channel leading up to Flushing was less than 4 feet at mean low water.

The project for improvement, adopted in 1879, contemplated building 16,700 feet of diking, to form a tidal basin which, by filling and discharging through the main channel, would maintain a channel depth of 6 feet or more at mean low water after once dredging; the bottom is soft mud. The estimated cost of this work was $173,500. A modification of the project, made in 1888, omits part of the diking.

During the past fiscal year the dike was extended 1,606 feet and shoals were dredged from the channel.

The present length of the dike is 4,663 feet.

July 1, 1889, amount available	$5,739.77
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	3,596.36
July 1, 1890, balance available	2,143.41
Amount appropriated by act of September 19, 1890	20,000.00
Amount available for fiscal year ending June 30, 1891	22,143.41
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	68,500.00

(See Appendix D 20.)

21. *Removing sunken vessels or craft obstructing or endangering navigation.*—The passenger steamer *Bay Ridge*, burned and sunk in the channel of Hempstead Harbor, N. Y., on the night of August 10, 1888. The owner attempted to remove the wreck, but abandoned it before completing the work, and in 1889 the Government was asked to undertake it.

Removal of this wreck was authorized, and after due advertisement a contract was entered into, under which the wreck was completely removed to the level of the surrounding bottom during the fall of 1889.

(See Appendix D 21.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENT, TO COMPLY WITH REQUIREMENTS OF RIVER AND HARBOR ACT OF AUGUST 11, 1888.

It appearing from the preliminary examination made by the local engineer that the following localities are worthy of improvement, and the public necessity therefor being apparent from the facts and reasons reported, which are concurred in by the Chief of Engineers, Colonel

Houston was charged with and completed their survey, the results of which were transmitted to Congress and printed in Ex. Doc's. of the Fifty-first Congress, first session.

1. *Brown's Creek, Sayville, New York.*—Printed as House Ex. Doc. 22. (See also Appendix D 22.)

2. *Larchmont Harbor, New York.*—Printed as House Ex. Doc. 40. (See also Appendix D 23.)

IMPROVEMENT OF HUDSON RIVER AND OF HARBORS OF RONDOUT AND SAUGERTIES, NEW YORK—REMOVING OBSTRUCTIONS IN EAST RIVER AND HELL GATE—IMPROVEMENT OF ENTRANCE TO NEW YORK HARBOR—IMPROVEMENT OF RIVERS AND HARBORS IN THE VICINITY OF NEW YORK AND IN NORTHERN NEW JERSEY.

Officer in charge, Lieut. Col. G. L. Gillespie, Corps of Engineers, having under his immediate orders Lieut. Harry Taylor, Corps of Engineers.

1. *Hudson River, New York.*—The improvement of this river has been restricted by the wording of the appropriation acts to that part of it lying between Troy, at the head of navigation, 6 miles above Albany, and New Baltimore, about 14 miles below Albany.

Before the improvement was begun the navigable depth in the channel between New Baltimore and Albany was 7½ feet at mean low water; between Albany and Troy, 4 feet.

The plan of improvement adopted in 1867 proposed making the navigable depth between New Baltimore and Albany 11 feet, and between Albany and Troy 9 feet. This was to be accomplished by the construction of longitudinal dikes to direct the currents, and by dredging.

The estimated cost of making this improvement, prepared in 1882, subject to be increased annually, was $1,078,304. In 1889 the estimated cost was $1,424,435.

The amount expended to June 30, 1889, inclusive of outstanding liabilities, was $1,033,739.59, of which sum a large part has, however, from the necessity of the case, been applied to the repair of decaying dikes instead of to the construction of the new dikes yet to be built. At that date the dikes provided for in the project of improvement, so far as built, have resulted in securing a channel depth of 10 feet nearly all the way from New Baltimore to Albany, and of 8 feet nearly all the way from Albany to Troy. The shoal spots make the navigable depths on those parts of the river 9½ feet and 7½ feet, respectively.

The amount expended during the fiscal year ending June 30, 1890, inclusive of outstanding liabilities, was $31,573.05, and was applied to the repairs of the dikes and to the construction of a new dike at Mull's Plaat.

July 1, 1889, amount available		$94,856.28
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$31,365.05	
July 1, 1890, outstanding liabilities	8,656.35	
July 1, 1890, amount covered by uncompleted contracts made during the fiscal year ending June 30, 1890	44,396.15	
		84,417.55
July 1, 1890, balance available		10,438.73
Amount appropriated by act of September 19, 1890		150,000.00
Amount available for fiscal year ending June 30, 1891		160,438.73
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867		145,000.00

(See Appendix E 1.)

2. *Harbor at Saugerties, New York.*—This harbor is formed by the mouth of Esopus Creek, which empties into the Hudson River, on the west bank, about 100 miles above New York City.

The bar at the entrance at the time of original examination, made in November, 1883, with the view of preparing estimates for improvement, had a navigable depth of 3 feet only at mean low water, and the distance between the 6-foot curves across it was 1,100 feet. The harbor could therefore be entered only at high water even by the smallest class of vessels.

The plan of improvement, which was adopted in 1887, provided for securing a depth of 8 feet, mean low water, from the entrance to the head of navigation, 1¾ miles, by the construction of two parallel dikes, each 2,300 feet long, 260 feet apart on the inside, and 280 feet apart on the outside, and by dredging, if found necessary, 30,000 cubic yards of material from the channel between the dikes.

The estimated cost of the improvement was $52,000; the amount expended upon the project up to the close of the fiscal year ending June 30, 1889, inclusive of outstanding liabilities, was $17,485.21.

At that date the south dike had been completed, and its length by actual measurement was 2,363½ feet; the shoal on the inside opposite Freligh's Wharf had been removed to a depth of 8½ feet, mean low water, and a channel across the bar at the entrance had been opened 200 feet wide and 9 feet deep, mean low water.

The amount expended during the fiscal year ending June 30, 1890, inclusive of outstanding liabilities, was $12,382.90, and was applied in dredging a cut 50 feet wide and 7 to 8 feet deep in the shoal in front of Sheffield's paper mill, and in the construction of 700 feet of pile and 109½ feet of crib dike on the north side of the creek.

The existing navigable depth from the entrance to the head of navigation is 9 feet mean low water in a channel from 100 to 300 feet wide.

July 1, 1889, amount available	$2,436.75
July 1, 1890, money value of work done during the fiscal year under contracts made prior to June 30, 1889	8,139.87
	10,576.62
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	9,854.69
July 1, 1890, balance available	721.93
Amount appropriated by act of September 19, 1890	10,000.00
Amount available for fiscal year ending June 30, 1891	10,721.93
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	10,000.00

(See Appendix E 2.)

3. *Harbor at Rondout, New York.*—This harbor is formed by the mouth of Rondout Creek, which empties into the Hudson River on its west side about 90 miles above the city of New York, and is the eastern terminus of the Delaware and Hudson Canal. The creek is a tidal stream for 3 miles above its mouth, and prior to 1871 all improvements had been made by private parties.

The Government made a survey of the harbor in 1869, and the available depth of water then in the channel was only 7 feet at mean low water. The project of improvement, based on this survey, was for the formation and maintenance of a channel 100 feet wide and 14 feet deep, mean low water, at the mouth of the creek, to be obtained by means of

dikes and dredging. Two parallel channel-dikes, 350 feet apart at the entrance, were to be built outward, toward, and into the Hudson River, and a branch dike up-stream to protect the north dike against destruction by ice.

The estimated cost of the project was $172,500.

The project was completed in 1880 at an actual cost of $90,000 only. At that time the length of the north dike was 2,200 feet, and that of the south dike 2,800 feet, and there was a channel between them 50 feet wide and 13½ feet deep, mean low water, and 100 feet wide and 12 feet deep, mean low water.

The appropriations which have been made since 1880 have been applied exclusively to the repair of the dikes.

The amount expended upon the project and upon repairs up to the close of the fiscal year ending June 30, 1889, inclusive of outstanding liabilities, was $96,452.29, at which date the navigable channel was 100 feet wide and from 12½ to 13½ feet deep, mean low water. The dikes were built originally of timber and stone to the height of mean high water, but the timber has since become so damaged by age and by the ice that the stone filling in many places has fallen out from between the rows of piles, and the height of the dikes has been correspondingly lowered.

It is recommended that the dikes be repaired in the future by the use of stone alone, so that they may be gradually converted into more permanent structures, excepting where very near the channel, where a new row of piles driven closely together, connected by double waling timbers and tied back to anchor piles in rear of dike, is recommended.

The amount expended during the fiscal year ending June 30, 1890, inclusive of outstanding liabilities, was $5,047.71, and was applied in repairing both dikes, and the piers are now in fair condition, except that 1,000 cubic yards of stone are needed to give required security to dikes.

July 1, 1889, amount available	$5,047.71
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	5,047.71
Amount appropriated by act of September 19, 1890	5,000.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	20,000.00

(See Appendix E 3.)

4. *Harlem River, New York.*—The Harlem River and Spuyten Duyvil Creek are both included in this improvement. The head of navigation in the former is practically at the High Bridge, about 5 miles from its junction with the East River; in the latter, at Kingsbridge, about 1¾ miles from the Hudson River, for vessels of 8 feet draught, at high water only.

The object of the improvement is to form a navigable channel between the East and Hudson rivers.

The project for the improvement as originally adopted in 1875 was for a channel 350 feet wide and 15 feet deep at mean low water. In 1879 the project was so far modified as to increase the width of the channel in the Harlem River and Spuyten Duyvil Creek to 400 feet, and retaining the original width of 350 feet through Dyckman's Meadow, but increasing the depth to 18 feet, mean low water. This

project was revised in 1886 by narrowing the channel, immediately north of High Bridge, where it skirts the Ogden estate on the east bank, to a least width of 375 feet.

The estimated cost of the work was $2,700,000; the amount expended upon the improvement up to the close of the fiscal year ending June 30, 1889, inclusive of outstanding liabilities, was $189,927.35. At that date 152,973 cubic yards had been removed by the contractor from the cut through Dyckman's Meadow.

The amount expended during the fiscal year ending June 30, 1890, inclusive of outstanding liabilities, was $143,754.60, and was applied in continuing the excavation of the cut through Dyckman's Meadow and in constructing a coffer-dam at the eastern end of the cut. At that date the excavation of the canal prism had been carried down to grade at the eastern end of the cut west of Kingsbridge road for a length of 317 feet, measured along the axis of the canal, and to nearly the full width of the channel; and at the western end, for a length of 438 feet and width of 124 feet, giving a total area of 146,110 square feet where the excavation had reached grade; over a large additional area the general level of the surface had been reduced to a plane but a few feet above grade.

The dam to the east of the Kingsbridge road, to keep out the waters the of Harlem River from the cut, had been completed, the site of the work drained, and the removal of material under the second contract had been begun.

July 1, 1889, amount available		$117,872.80
July 1, 1890, money value of work done during fiscal year under contracts made prior to June 30, 1889		122,960.07
		240,832.87
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$117,948.00	
July 1, 1890, outstanding liabilities	39,908.73	
July 1, 1890, amount covered by uncompleted contracts made during the fiscal year ending June 30, 1890	62,401.33	
		220,258.06
July 1, 1890, balance available		20,574.81
Amount appropriated by act of September 19, 1890		250,000.00
Amount available for fiscal year ending June 30, 1891		270,574.81
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		1,980,000.00

(See Appendix E 4.)

5. *Removing obstructions in East River and Hell Gate.*—Hell Gate is the worst obstruction in the narrow strait connecting Long Island Sound with New York Harbor, known as the East River.

At this point the channel turns at right angles around Hallet's Point, opposite the mouth of the Harlem River, and the current runs with a velocity varying at different stages of the tide from 3 to 10 miles an hour over or around Way's Reef, Pot Rock, Shell Drake, Frying Pan, Hallet's Point, Negro Point, Holmes' Rock, Hog's Back, Heel Tap, Flood Rock, Hen and Chickens, Gridiron, Mill Rocks, the Negro Heads, Rhinelander's Reef, and Bread and Cheese.

Besides these most serious obstructions there are many other rocks and reefs in the East River, especially those off the Battery, off Thirty-third street, Charlotte Rock, Shell Reef, off Tenth street, and Middle

Ground off Sunken Meadows, which are dangerous to its crowded navigation, and which ought to be removed.

Originally the channel of East River and Hell Gate contained many large and dangerous rocky obstructions to navigation.

The depth over Diamond Reef at mean low water was 17½ feet; over Coenties Reef, 14.3 feet; over Frying Pan, 11 feet; over Pot Rock, 20 feet; over Heel Tap, 12.1 feet, and over reef at North Brothers Island, 16 feet. Hallets Point projected from the shore at Astoria under water 325 feet to the contour of 26 feet at mean low water and embraced an area of about 3 acres. The Middle Reef, with an area of about 9 acres, lay in the middle of the channels at Hell Gate; it had a small backbone projecting above high water, called Flood Rock, upon which vessels were stranded when driven there by the ebb currents which swept directly over the rock.

The project, originally adopted in 1867, provided for the removal of the rocks and reefs that lay directly in the channel at Hell Gate to a depth of 26 feet at mean low water, and for the building of sea-walls and dikes upon others that lay near the edge of the channel. The cost of the project was estimated at $8,692,645.15 (Annual Report, Chief of Engineers, 1868, page 741). This estimate was revised in 1870 and the cost placed at $4,689,820. The estimate was again revised in 1874 to include the removal of Diamond and Coenties reefs, and the total cost fixed at $5,139,120 (Annual Report Chief of Engineers, 1874, Part II, page 164). It provided for the removal, at Hell Gate, to a depth of 26 feet, mean low water, of the reef at Hallets Point, Way's Reef, Shell Drake, Pot Rock, Frying Pan, Heel Tap, Negro Point, and Flood Rock, including the Gridiron, Hen and Chickens, and Negro Heads, and for the construction of a dike to connect the Mill Rocks, and sea-walls upon Hog's Back and Holmes' Rock; and, in other parts of the East River, for the removal of Diamond and North Brothers Island reefs to a depth of 26 feet; Coenties Reef to a depth of 25½ feet; and the small rocks known as Scaly Rock, Blackwell's Rock, and rock off Woolsey's Bath House.

The project was enlarged in 1884 to include the removal of Pilgrim Rock, off Nineteenth street, and again in 1889 to include the removal of the reef off Diamond Reef, reef off Thirty-third street, and Charlotte Rock, northwest of entrance to Newtown Creek.

The amount expended up to the close of the fiscal year ending June 30, 1889, inclusive of outstanding liabilities, was $3,709,457.64.

At that date Hallets Point, covering 3 acres, Way's Reef, Shell Drake, Diamond Reef, North Brothers' Island Reef, Coenties Reef, and Scaly Rock had been removed to the depth contemplated in the project; Pilgrim Rock had been reduced to a least depth of 24 feet; Heel Tap had been broken to 26 feet and dredged to 20.5 feet, and the least depths on Frying Pan and Pot Rock were 18 feet and 22.8 feet at mean low water respectively; Flood Rock and connecting reefs, covering 9 acres, had been broken to 30 feet, and 85,095 tons of the debris had been removed; the Negro Heads and Hen and Chickens had been reduced to 18 feet, mean low water, and a new 18-foot channel, 380 feet wide, had been opened across the reef.

Sea-walls had been built by the Government to connect Great and Little Mill Rocks, and by the city authorities on Bread and Cheese Reef.

These results have been of the greatest value to navigation.

The amount expended during the fiscal year ending June 30, 1890, inclusive of outstanding liabilities, was $162,855.07, and was applied

in removing, by hired labor, 47,399 tons of broken stone from Flood Rock, by the use of the two United States engineer dredges, Nos. 5 and 6, and in removing 3,228 tons of rock by the use of the United States steam-drill scow on reef off Diamond Reef and reef off Thirty-third street.

The new 18-foot channel across Flood Rock has been widened to 500 feet, and the area of the 26-foot curve over the main reef south of that channel reduced materially. The reef off Thirty-third street has been reduced from a least depth of 7.1 feet to a least depth of 19 feet, mean low water, and the removal of the reef off Diamond Reef has been nearly completed.

July 1, 1889, amount available		$190,903.43
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$95,617.15	
July 1, 1890, outstanding liabilities	9,570.05	
		105,187.20
July 1, 1890, balance available		85,716.23
Amount appropriated by act of September 19, 1890		200,000.00
Amount available for fiscal year ending June 30, 1891		285,716.23
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		1,038,840.67

(See Appendix E 5.)

6. *Newtown Creek, New York*—This is a tidal stream, about 4 miles long, running through the eastern part of Brooklyn, and emptying into the East River opposite Thirty-fourth street, New York City.

It had formerly a depth of 12½ feet, mean low water, at the mouth, gradually decreasing to 4 feet at the head.

The original project for its improvement, adopted in 1880, but modified in 1883, provided for a channel 200 feet wide and 21 to 22 feet deep, mean low water, extending from the mouth up to Vernon Avenue Bridge, and from that point up to the head of navigation, on both branches, a channel decreasing from 175 feet to 100 feet in width, and from 18 feet to 10 feet in depth, at an estimated cost of $255,569.

The amount expended up to the close of the fiscal year ending June 30, 1889, inclusive of outstanding liabilities, was $83,914.97.

At that date the channel immediately below Vernon Avenue Bridge was 100 feet wide and 18 feet deep, and on the bar the width was 75 feet and 16 feet deep only, mean low water, while at the head of navigation both branches had shoaled 3½ feet approximately, reducing the depth in the channels there to 6½ feet, mean low water. The intermediate section had slightly deepened, though no work had ever been done there.

The amount expended during the fiscal year ending June 30, 1890, was $17,223.20, inclusive of outstanding liabilities, and was applied in dredging 83,850 cubic yards of material from the entrance to Queens County Oil Works, resulting in a channel 60 feet wide and 21 feet deep, mean low water, from the entrance to Vernon Avenue Bridge; 80 feet wide and 18 feet deep, mean low water, from Vernon Avenue Bridge to Central Oil Works; and the removal to a depth of 10 feet of the Middle Ground opposite the Queens County Oil Works.

The existing channel is not adequate in width or depth to the demands of commerce, and the adopted project for improvement should be completed as early as practicable by methods which will carry the improvement progressively from the mouth to the head of navigation.

From information gained during the year in regard to the necessities of this stream, it is believed that the depth from the entrance to Vernon Avenue Bridge may properly be increased to 23 feet, mean low water; thence to Penny Bridge to 20 feet; and thence to Metropolitan Avenue, 12 feet.

July 1, 1889, amount available		$2,816.56
July 1, 1890, money value of work done during the fiscal year under contracts made prior to June 30, 1889		15,512.28
		18,328.84
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$16,312.05	
July 1, 1890, outstanding liabilities	1,738.50	
		18,050.55
July 1, 1890, balance available		278.29
Amount appropriated by act of September 19, 1890		35,000.00
Amount available for fiscal year ending June 30, 1891		35,278.29
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		113,000.00

(See Appendix E 6.)

7. *Buttermilk Channel, New York Harbor.*—Buttermilk Channel lies between the city of Brooklyn, N. Y., and Governor's Island, New York Harbor, and is obstructed at its upper end, where it joins the East River, by a shoal, over which there was formerly a least depth of 9½ feet at mean low water. The crest of this shoal lay about 800 feet distant from the line of the Brooklyn wharves.

The original project of improvement, adopted in 1881, provided for the removal to a depth of 26 feet, mean low water, of such parts of the shoal as came within 850 feet of the Brooklyn wharves, which would take off the crest of the shoal and give elsewhere a depth of not less than 15 feet, mean low water.

The estimated cost of the improvement was $210,000. In view of the increasing importance of the wharves on the Brooklyn shores and the difficulty experienced by deep-draught vessels in getting up to them by reason of this shoal, the project of improvement was modified in 1885 so as to provide for the removal of the entire shoal to a depth of 26 feet, mean low water, at an estimated additional cost of $150,000, making the total estimated cost of the project $360,000.

The amount expended up to the close of the fiscal year ending June 30, 1889, inclusive of outstanding liabilities, was $241,509.01.

At that time the width of the channel adjacent to the Brooklyn wharves, in which the depth was 24 feet and over, did not exceed 600 feet, and the water had been deepened over the entire surface of the shoal to 22 feet, mean low water, except on the extreme western side, where the average depth was 21 feet only, with a few isolated spots upon which the depth was 19 feet only.

The amount expended during the fiscal year ending June 30, 1890, inclusive of outstanding liabilities, was $31,470.95, and was applied in dredging 206,199 cubic yards of material from the shoal. The south end of the shoal for a distance of 500 feet, approximately, along the axis has been dredged to 26 feet mean low water, and a cut 450 feet wide and 26 feet deep has been carried north and south through the entire length of the shoal, together with a second cut 100 feet wide for one-half the length of the shoal.

By the operations of the contract now in progress the approved proj-

ect will be entirely completed. It is expected that a small balance will be available for application upon the shoal opposite Red Hook Point.

This latter shoal containing, it is estimated, 1,681,439 cubic yards, approximately, obstructs the southern entrance to the channel, but its entire removal is not included in the present project for improvement.

It is important that the Red Hook Shoal should be removed so as to give along the Atlantic Basin the full depth of 26 feet mean low water, which is projected for other points in the harbor, and to facilitate communication with the East River through the improved Buttermilk Channel.

July 1, 1889, amount available		$12,340.99
July 1, 1890, money value of work done during the fiscal year under contracts made prior to June 30, 1889		38,146.84
		50,487.83
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$31,470.95	
July 1,1890, outstanding liabilities	8,632.19	
		40,103.14
July 1, 1890, balance available		10,384.69

(See Appendix E 7.)

8. *Gowanus Bay, New York.*—Gowanus Bay is a part of New York Harbor, lying at the mouth of Gowanus Creek, in the southwestern part of the city of Brooklyn.

The depth of water in the channel of Gowanus Creek and Bay was originally only from 7 to 12 feet at mean low water, which was wholly insufficient for the passage of vessels employed in the commerce of the district.

The plan of improvement adopted in 1881 provided for a depth of 18 feet to the channels in the bay leading up to the mouth of the creek on both the north and south sides, and for carrying the improvement with the same depth up the creek to Hamilton Avenue Bridge, a distance of 1 mile.

The channel widths were to be 200 feet, except for the last few hundred feet up to the bridge, in which distance the width would gradually decrease.

The estimated cost of this improvement was $192,564.90.

The project of 1881 was modified in 1888 by increasing the depth to 21 feet and the width to 400 feet, while to facilitate the handling of vessels in the contracted space near the mouth of Gowanus Creek more room should be gained by cutting away the angle on the south side, at an estimated cost of $600,000.

The amount expended to the close of the fiscal year ending June 30, 1889, inclusive of outstanding liabilities, was $80,675.01.

At that date the improved channel, under the modified project, had been carried 25 feet wide and 21 feet deep from the entrance to Erie Basin up to Percival street, Brooklyn; the channel on the south side (Bay Ridge Channel) had been completed in 1884 for the full projected width of 200 feet and depth of 18 feet to a point 2,000 feet south of the mouth of the creek.

The amount expended during the fiscal year ending June 30, 1890, inclusive of outstanding liabilities, was $25,940.24, and was applied in removing 135,967 cubic yards of material from the Red Hook and Gowanus Creek channels. At that date the channel from the entrance to Erie Basin to the foot of Percival street was about 75 feet wide and from 19 to 21 feet deep mean low water, and the triangular slip at the *foot of* Bryant street had been dredged to 21 feet.

On the completion of the contract now in progress the improved channels will be throughout 100 feet wide and 21 feet deep.

July 1, 1889, amount available		$3,528.52
July 1, 1890, money value of work done during the fiscal year under contracts made prior to June 30, 1889		25,153.91
		28,682.43
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$22,113.58	
July 1, 1890, outstanding liabilities	4,641.83	
		26,755.41
July 1, 1890, balance available		1,927.02
Amount appropriated by act of September 19, 1890		60,000.00
Amount available for fiscal year ending June 30, 1891		61,927.02
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		480,000.00

(See Appendix E 8.)

9. *New York Harbor, New York.*—Before the improvement of the main entrance into New York Harbor was undertaken by the United States the least depth in mid-channel on the bar was 23.7 feet at mean low water, and the same depth could be carried across three other shoals between the bar and deep water in the harbor.

A large proportion of the vast commerce of the port which is carried on in vessels of great draught could only cross these shoals at or near high water.

The project for the improvement of Gedney's Channel was approved by the Secretary of War in December, 1884, and its extension to cover the whole of the main entrance to the harbor received his approval December 27, 1886. It provides for dredging a channel 1,000 feet wide and 30 feet deep, at mean low water, from deep water below the Narrows through the main ship channel and Gedney's Channel to deep water outside the bar, maintaining this channel, should it be necessary, either by periodical dredging, or by contracting the entrance by the construction of a dike running across the shoals from the Coney Island side with suitable protection for the head of Sandy Hook to prevent its being scoured away by the increased current.

The estimated cost of obtaining the dredged channel is $1,490,000 for dredging 4,300,000 cubic yards, and the entire cost of the improvement, should the contraction works prove to be necessary, is estimated at between $5,000,000 and $6,000,000.

Under this project an extended survey of the Lower Bay had been made, on which the method of improvement was based.

The total amount expended to June 30, 1889, inclusive of outstanding liabilities, was $808,411.74.

At that time the channel over the bar in Gedney's Channel was 500 feet wide, with a least depth of 30 feet, mean low water; in Bayside Channel, 1,000 feet wide, with a least depth of 30 feet at mean low water; and in the Main Ship Channel, west of Flynn's Knoll, 350 feet wide, and a least depth of 30 feet at mean low water. In the latter channel the 29-foot channel had a width of 500 feet, and in the Bayside Channel the Northwest Shoal had been entirely removed to the depth of 30 feet, mean low water.

The amount expended during the fiscal year ending June 30, 1890, inclusive of outstanding liabilities, was $354,622.21.

During the year the contracts with The Joseph Edwards Dredging Company, dated May 19, 1887, and December 8, 1888, for the removal of 1,500,000 cubic yards and 600,000 cubic yards, respectively, and the working agreement with Brainard Brothers, dated May 11, 1888, for the removal of 200,000 cubic yards, were completed.

The contract with The Joseph Edwards Dredging Company, dated March 18, 1890, for the removal of 425,000 cubic yards, has progressed satisfactorily, and at the close of the fiscal year 233,689 cubic yards had been removed.

The contract with the Brainard Dredging Company, dated November 26, 1889, was conducted badly from the beginning, and on the 18th of June was practically abandoned, as the plant owned originally by the company was sold for debt June 17, and the chartered plant was withdrawn June 18.

The aggregate number of yards removed by the contractors during the year was 1,318,178 cubic yards, of which number 376,632 were removed from the Gedney's Channel Division, and 941,546 from the Main Ship Channel, west of Flynn's Knoll.

As a result of this work a survey made in February, 1890, shows that Gedney's Channel and Bayside Channel (east and west) are practically completed, having a depth of 30 feet, mean low water, for the full projected width of 1,000 feet. The Main Ship Channel, west of Flynn's Knoll and south of Buoy 12, has a depth of 30 feet, mean low water, for a width varying from 500 to 800 feet, and a depth of 28 feet for a width of 800 feet throughout.

Under authority from the Chief of Engineers, dated February 20, 1890, a riprap wall, containing 5,000 tons of stone, approximately, will be built along the north shore of Sandy Hook, to protect foundations of the fort and other public structures. Operations will be begun in July.

July 1, 1889, amount available		$315,581.40
July 1, 1890, money value of work done during fiscal year under contracts made prior to June 30, 1889		206,006.86
		521,588.26
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July, 1889	$288,071.41	
July 1, 1890, outstanding liabilities	39,213.65	
July 1, 1890, amount covered by uncompleted contracts made during the fiscal year ending June 30, 1890	177,694.24	
		504,979.30
July 1, 1890, balance available		16,608.96
Amount appropriated by act of September 19, 1890		160,000.00
Amount available for fiscal year ending June 30, 1891		176,608.96

(See Appendix E 9.)

10. *Raritan Bay, New Jersey.*—Raritan Bay forms the western part of the large triangular bay inclosed between Sandy Hook, the New Jersey shore, and Staten Island.

The channel undergoing improvement lies to the southeast of Seguine's Point, on the south shore of Staten Island. At the time of the original survey, August, 1880, the least depth on the shoal lying between the 21-foot curve at Seguine's Point and the 21-foot curve at the head of the bay was 14½ feet, mean low water. The project of improvement, based upon the survey, provided for a channel across the shoal 300 feet wide and 21 feet deep, mean low water, at an estimated cost of $126,500.

The project was modified in 1885, extending the improvement by

providing for a channel of equal width and depth over the shoals in the vicinity of Ward's Point, Staten Island, where the original depth was 18 feet, mean low water, so as to give a navigable channel 21 feet deep, mean low water, up to Perth Amboy, and for a channel 300 feet wide and 15 feet deep, mean low water, from Great Beds Light to South Amboy, where the original depth was 12½ feet, mean low water, at an estimated cost of $240,500, for the entire work from the beginning, which estimate was again increased in 1888 to $246,500, to provide for the removal of deposits which had taken place in the interval of three years.

The channel from deep water at the head of Raritan Bay, past Seguine's Point to Perth Amboy, exceeds 5 miles in length, is crooked, and is subject to constant shoalings. As the amount appropriated, any one year, for the execution of the project has been much less than the estimated cost of the improvement, and as the channel excavated under each appropriation has been impaired by shoaling in a greater or less degree before work could be resumed under the succeeding appropriation, the original estimates for this improvement have little value, and can not be used for determining the amount required for completing the project at this date. The estimated cost for completing the project, if all the required money could be made available at this time, is $175,375.

The amount expended upon the modified project up to the close of the fiscal year ending June 30, 1889, inclusive of outstanding liabilities, was $154,167.45. At that date the channel was 300 feet wide and 21 feet deep, mean low water, from Perth Amboy to the bend at Great Beds Light, and 300 feet wide and 20 feet deep, mean low water, across the crest of the shoal in the channel leading from the bend towards Seguine's Point. The channel eastward of Seguine's Point had a depth not exceeding 18 feet, mean low water. The channel leading to South Amboy had not been begun.

The amount expended during the fiscal year ending June 30, 1890, inclusive of outstanding liabilities, was $23,457.70, and was applied in dredging a channel from 70 to 80 feet wide and 15 feet deep, mean low water, in the channel from Great Beds light to South Amboy, and a channel 100 feet wide and 21 feet deep, mean low water, in the channel east of Seguine's Point. No work has been done during the year on the other parts of the project.

The channel leading to Perth Amboy should be deepened as early as practicable to 21 feet, mean low water; that to South Amboy widened to 300 feet, 15 feet deep, mean low water; and that across the shoal to the eastward of Seguine's Point widened and deepened as the project provides.

July 1, 1889, amount available	$3,197.42
July 1, 1890, money value of work done during the fiscal year under contracts made prior to June 30, 1889	22,200.00
	25,397.42
July 1, 1890, amount expended during the fiscal year exclusive of liabilities outstanding July 1, 1889	23,457.70
July 1, 1890, balance available	1,939.72
Amount appropriated by act of September 19, 1890	40,000.00
Amount available for fiscal year ending June 30, 1891	41,939.72
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	135,375.00

(See Appendix E 10.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENT, TO COMPLY WITH REQUIREMENTS OF RIVER AND HARBOR ACT OF AUGUST 11, 1888.

It appearing from the preliminary examination made by the local engineer that the following localities are worthy of improvement, and the public necessity therefor being apparent from the facts and reasons reported, which are concurred in by the Chief of Engineers, Lieutenant-Colonel Gillespie was charged with and completed their survey, the results of which were transmitted to Congress and printed in Ex. Doc's. of the Fifty-first Congress, first session.

1. *Wappinger's Creek from Wappinger's Falls to its mouth, New York.*—Printed as House Ex. Doc. 25. (See also Appendix E 11.)

2. *East River, with a view to the removal of a ledge of rocks in the same, from the foot of Broome street to the foot of Twenty-third street, in New York City.*—Printed as House Ex. Doc. 169. (See also Appendix E 12.)

IMPROVEMENTS OF SHEEPSHEAD AND CANARSIE BAYS, AND SUMPAWANUS INLET, NEW YORK—OF ARTHUR KILL, NEW YORK AND NEW JERSEY—OF CHANNEL BETWEEN STATEN ISLAND AND NEW JERSEY—OF RIVERS IN NORTHERN NEW JERSEY, AND OF THE HARBOR OF KEYPORT.

Officer in charge, Capt. Thos. L. Casey, Corps of Engineers; Division Engineer, Col. H. L. Abbot, Corps of Engineers.

1. *Sheepshead Bay, New York.*—The original condition of the navigable channel was, for the entrance a depth of a little over 2 feet at mean low water, and for the interior channel not less than 4 feet, except at two narrow bulkheads across said channel.

The originally adopted project (1879) was to deepen the entrance by means of converging jetties, and to improve the interior channel by longitudinal dikes, so placed as in some instances to form tidal reservoirs for the scour of the channel. The project was revised in 1881, and provides for excavating a channel at the outlet 100 feet wide and 6 feet deep at mean low water, to connect the bay with Dead Horse Inlet and to dredge the interior channel.

The amount expended under the revised project to end of the fiscal year ending June 30, 1889, was $16,904.85. With this amount a channel had been dredged 100 feet wide, and 6 feet deep at mean low water, connecting the east end of the bay with Dead Horse Inlet. A survey made in 1887 shows that this channel has not maintained itself, having contracted to a width of 60 feet with an average depth of 5½ feet mean low water.

The original project for the formation and maintenance of a channel 100 feet wide and 6 feet deep mean low water was modified in February, 1889; the modified project contemplating a channel 5,350 feet long, 60 feet wide and 5½ feet deep mean low water, from the town of Sheepshead to within 1,080 feet of Dead Horse Inlet Cut, to connect with the above-mentioned channel of similar width and depth already existing at that point.

The expenditures during the fiscal year amount to $8,375.12, with which the interior channel has been dredged to a width of 60 feet and depth of 5½ feet mean low water for a distance of 3,400 feet, from the town of Sheepshead toward Dead Horse Inlet.

It is estimated that the commerce of this waterway has increased about 800 tons over that reported in 1884.

July 1, 1889, amount available	$1,034.40
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	320.92
July 1, 1890, balance available	713.48
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	8,200.00

(See Appendix F 1.)

2. *Canarsie Bay, New York.*—The original condition of the channel leading to Canarsie answered to a depth of 4½ feet mean low water.

The original project, adopted in 1879, provides for obtaining a navigable channel 6 feet deep at mean low water from Canarsie Landing to the deep water in Jamaica Bay, by means of diking and the formation of a tidal basin. In the Annual Report of the Chief of Engineers, 1880, Part I, page 574, General Newton expressed a doubt as to adequate appropriations being made for carrying out the authorized project, and suggested that dredging be tried as an expedient.

The amount expended to the close of the fiscal year ending June 30, 1889, was $41,390.74. With this amount two pile-dikes have been built, one on the north side of the outer end of the channel, the other on the south side, their lengths being 1,058 feet and 820 feet respectively; the channel dredged to a depth of 6 feet mean low water, and width of from 50 to 125 feet from Canarsie Landing to deep water in Jamaica Bay, besides several minor improvements not contemplated in the original project.

The expenditures during the fiscal year amount to $1,095.25 with which a cut 1,193 feet long, 25 feet wide, and 5 feet deep, had been made from the end of the wharf at Canarsie through to the southwest to connect with the southwest channel.

The commerce of Canarsie Bay for 1889 shows an increase of about 5,500 tons over that reported in 1887.

July 1, 1889, amount available	$1,607.26
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,093.25
July 1, 1890, balance available	514.01
Amount appropriated by act of September 19, 1890	5,000.00
Amount available for fiscal year ending June 30, 1891	5,514.01
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	40,000.00

(See Appendix F 2.)

3. *Sumpawanus Inlet, New York.*—The channel depth at the time of the adoption of the project varied from 5 feet in the bay at mean low water to 2 feet at the wharf at the mouth of the creek, a distance of a little over half a mile.

The project for the improvement of this inlet, known locally as Sumpawanus Creek, adopted in 1880, provided for dredging a channel about 4,500 feet long, and from 100 to 150 feet wide and 5 feet deep at mean low water, beginning at the 5-foot curve in the Great South Bay and extending up to the town of Babylon, Long Island.

The amount expended under this project to June 30, 1889, was $6,982.87, with which a channel 75 feet wide and 5 feet deep from the steam-boat wharf to a point 750 feet below it, was dredged, besides dredging two cuts, each 25 feet wide, alongside of the wharf.

Outside of the cuts so made and extending to the 5-foot curve in the bay a shoal was left, on which the depth was only about 4¾ feet.

An examination made in 1886 showed that since the last dredging was done, in 1883, both the cut and the flat outside had shoaled from 6 inches to 1 foot, the depth in the cut being about 5 feet, while on the flat it was from 4 to 4½ feet. This was to have been anticipated, as appears by the preliminary report made by General Newton. The 5-foot curve in the bay was about 1,500 feet from the steam-boat wharf, but inside this curve, for about 750 feet, towards the wharf, lay the flat.

The commerce of Sumpawanus Creek is essentially that of Babylon, a small town of from 3,000 to 5,000 inhabitants, 1 mile above the mouth of the creek, depending almost entirely upon the summer trade of the hotels and cottages along the north shore of Great South Bay and on Fire Island Beach.

The commerce of Babylon by water has been decreasing, apparently because the Long Island Railroad has taken away the sea-going business. Babylon itself has improved, and has become a fashionable summer resort. At present its commerce by sea is carried on by three passenger steam-boats, drawing from 4 to 5 feet, and running in summer to Fire Island Beach; three schooners drawing from 5 to 5½ feet, carrying brick, lime, lumber, and other heavy freight to Babylon the year round; 100 sloops and pleasure-boats, drawing from 1 to 2 feet of water, taking out sailing and fishing parties during the summer, of which seven or eight remain in use during the winter fishing and taking oysters and clams to Patchogue, Sayville, and New York.

The expenditures during the fiscal year ending June 30, 1890, amount to $17.13 for office expenses.

July 1, 1889, amount available	$17.13
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	17.13
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	16,115.00

(See Appendix F 3.)

4. *Arthur Kill, New York and New Jersey.*—This is a new work, the appropriation for which, amounting to $10,000, is in the act of August 11, 1888.

The improvement consists for the present entirely in the removal of a point of land near and to the south of the Staten Island Bridge, for the purpose of straightening the channel in order that the currents may be directed more truly in a direction perpendicular to the draw-span of the bridge, thus facilitating the passage of long tows.

Condemnation proceedings for acquiring to the United States the land needed for this improvement were perfected in the United States Court for the Eastern District of New York on November 8, 1889, and payment for the same, amounting to $812.50, made as directed by the court. Authority to advertise the work was granted February 6, 1890. Bids were opened March 3, and a contract entered into March 24. Work was begun under the contract April 9, and finished May 20, the amount of material removed being 29,000 cubic yards, giving an additional width of 150 feet to the channel, with a depth of 13 feet mean low water, the amount of land removed being one-half acre.

The expenditures for the fiscal year, amounting to $2,161.15, have been for examination of channel, office expenses, and purchase of land needed for improvement.

July 1, 1889, amount available		$9,025.65
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$2,161.15	
July 1, 1890, outstanding liabilities	*6,832.25	
		8,993.40
July 1, 1890, balance available		32.25
Amount appropriated by act of September 19, 1890		7,000.00
Amount available for fiscal year ending June 30, 1891		7,032.25
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		9,500.00

(See Appendix F 4.)

5. *Channel between Staten Island and New Jersey.*—Before this improvement was undertaken by the United States there was a navigable channel having a minimum depth of 9.2 feet from the deep water in Newark Bay to Elizabethport.

The original project provided for obtaining, by means of dredging and a system of training-dikes, of a channel north of Shooter's Island, 6,500 feet long, 150 feet wide, and 16 feet deep at mean low water.

Under this project, 2,237 feet of dike was built. Owing to the opposition, mainly of the company engaged in the transportation of freight through the Delaware and Raritan Canal, a resolution was passed by the legislature of the State of New York, January 22, 1875, protesting against the projected method of improvement. Presumably in consequence of these resolutions, a Board of Engineers, appointed under section 3, act of March 3, 1875, to examine and report upon a plan for the improvement of the channel, convened at New York City May 12, 1875, and on November 20, 1875, submitted to the Chief of Engineers a report recommending that a channel 11 feet deep and 500 feet wide be dredged along the general lines of the existing channel. The project was again modified in 1880, so as to obtain a channel 400 feet wide and 13 feet deep over the middle, 200 feet and 12 feet deep on the outer 100 feet on each side; and, in addition, if found necessary, dikes were to be built on the opposite sides of the channel. Subsequently it was decided to give the channel 13 feet depth for its full width of 400 feet.

The amount expended to June 30, 1889, was $170,312.73, with which the channel was given depths of from 13 to 20.7 feet mean low water, throughout its length through widths varying from 160 to 350 feet, the narrowest portion being at the bend at the Stake Light, where it appears to be least stable.

The expenditures during the present fiscal year amount to $13,314.42.

A modification of the project having in view the abandonment of the dikes was approved by the Department May 15, 1889, and at the same time permission was granted for the expenditure of the appropriation of $15,000 made in the act of August 11, 1888, in dredging by contract. An examination made after the close of the contract shows that the channel in the vicinity of the Corner Stake Light has been given an additional width of 100 feet and a depth of 13 feet, mean low water, for a distance of 1,800 feet, the excavation being made from the north side of the channel. Between the Corner Stake Light and Long Dock it was widened by 70 feet through a distance of 1,000 feet, and by 35 feet for a further distance of 750 feet, with a depth of 13 feet mean low water,

* Owing to the absence of the contractor abroad the above amount due on the contract for dredging had not been paid at the close of the fiscal year.

the excavation being made in both the latter sections from the south side of the channel.

This dredging has resulted in considerable improvement of the channel in regard to width, which, because of the sharp turn at the Corner Stake Light, should be as great as is consistent with the maintaining power of the current. In my last report it was recommended that the channel at this point should be given a width of 400 feet, with a depth throughout of 13 feet at mean low water, at a total estimated cost of $30,000.

The reported increase in the commerce making use of this channel for the calendar year is about 380,000 tons.

July 1, 1889, amount available	$1,612.65
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,239.80
July 1, 1890, balance available	372.85
Amount appropriated by act of September 19, 1890	15,000.00
Amount available for fiscal year ending June 30, 1891	15,372.85
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	61,000.00

(See Appendix F 5.)

6. *Passaic River, New Jersey.*—This river is being improved under two separate projects, the first applying to the river above Center street or Pennsylvania Railroad Bridge, Newark, as far as Passaic, a distance of 8 miles, and the second to the lower course of the river, from the Center Street Bridge to beyond the shoals in Newark Bay, a distance of 7⅝ miles.

1. *Above Newark.*—Before its improvement was undertaken, the upper part of the river had a navigable 6-foot channel except at Middle, Belleville, Rutherford Park, and Holzsman's bars, where the depths were 4.5 feet, 3.9 feet, 3 feet, and 3.5 feet respectively.

The project of improvement was adopted in 1872 and provided for a channel across the above shoals from 7½ to 6 feet deep mean low water, and from 200 to 50 feet wide, to be obtained by dredging and diking, at a cost of $123,924. It was modified in 1885 by extending the channel below Middle Bar 1,500 feet to the Erie Railroad Bridge, increasing the estimate to $129,000.

Under this project $127,816.46 had been expended to June 30, 1889, and channels of the required depth had been dredged from 60 to 75 feet wide, excepting for a distance of 1,500 feet above the Erie Railroad Bridge.

No work of improvement has been done on the upper river during the fiscal year, the necessary dredging plant for doing the work, purchased in accordance with the approved project for the expenditure of the allotment made in the act of August 11, 1888, being continuously employed on the improvement of Raritan River, and the amount of funds available not being sufficiently large to guaranty an advantageous letting to dredging contractors. A survey of the river from the Pennsylvania Railroad Bridge, Center street, Newark, to the town of Passaic, was made during the year.

The commerce of the upper river was valued in 1884 at $1,032,000, and returns representing the business done by the firms located along the river show for the year 1889 a commerce valued at about $2,545,000.

The expenditures during the fiscal year, amounting to $1,885.82, have been for office expenses and prosecution of survey.

July 1, 1889, amount available	$5,933.54
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,885.82
July 1, 1890, balance available	4,047.72
Amount appropriated by act of September 19, 1890	5,100.00
Amount available for fiscal year ending June 30, 1891	9,147.72

(See Appendix F 6.)

2. *Below Newark.*—The lower portion of the river, from Center Street Bridge to Newark Bay, was first surveyed by the Engineer Department in 1879. The greatest depth in the channel, at a point above the Elbow Beacon, was only 7.1 feet, and in many places the greatest depth was 7.5 feet at mean low water.

A project was adopted, based on this survey, providing for obtaining by diking and dredging a channel 200 feet wide and 10 feet deep at mean low water from the Center Street Bridge to Newark Bay, at a cost of $232,875.

This project was modified in 1884, pursuant to the river and harbor act of that year, providing for extending the dike at the mouth of the river into the bay, a distance of 8,000 feet, and for dredging a channel across the shoal in Newark Bay 200 feet wide and 10 feet deep at mean low water, increasing the original estimate to $353,875.

June 30, 1889, $181,137.84, exclusive of outstanding liabilities, had been expended under this project, the dike at the mouth had been extended about 2,200 feet, making a total length of 6,205 feet. The channel through the shoal in the bay had been dredged to the required dimensions, as also the channel up the river as far as the Newark and New York Railroad Bridge. The remainder of the distance to the Center Street Bridge, the 10-foot channel had only been dredged from 130 to 100 feet in width. These results had been of very great benefit to the large commerce of the river, which was estimated in 1884 at 1,200,000 tons, valued at $30,000,000.

The amount expended during the fiscal year is $17,120.43 which has resulted in widening the 10-foot channel by 100 feet, from the Newark and New York Railroad Bridge up stream for a distance of 1,423 feet. The channel was also redredged to 10 feet depth at mean low water and widened to 180 feet for an additional distance of 1,150 feet, and around the bend above the toll-bridge the channel was regulated to a width of 100 feet, and depth of 10 feet mean low water for a further distance of 2,975 feet to Lister's Dock.

The commerce of this river was valued in 1887 at $40,693,500 and for 1889 it is given at $44,722,750, an increase in valuation of $4,029,250.

July 1, 1889, amount available	$18,269.53
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	17,027.80
July 1, 1890, balance available	1,241.73
Amount appropriated by act of September 19, 1890	40,000.00
Amount available for fiscal year ending June 30, 1891	41,241.73
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	114,375.00

(See Appendix F 6.)

7. *Elizabeth River, New Jersey.*—This stream, which is 2⅝ miles in length from its mouth to the head of navigation at Broad street, Eliza-

beth, has a width of from 50 to 90 feet, and before its improvement the wharves in the city could only be reached at high water by vessels drawing less than 4 feet; its commerce was estimated at 45,000 tons annually. The range of the tide was about 4.7 feet at its mouth and 3.4 feet at Bridge street.

The project for the improvement was adopted in 1878, and provides for obtaining, by dredging, a channel 60 feet wide and 7 feet deep at high water from the mouth of the river to the head of navigation, at an estimated cost of $25,530.

The amount expended under this project to June 30, 1889, was $26,900.85, and a channel had been dredged to the required depth to within 1,000 feet of the Broad Street Bridge. The reported increase in the commerce of this river for 1889 is 9,450 tons.

The condition of the river has deteriorated since work was suspended. When last examined vessels drawing 5 feet could ascend the river to the head of the dredged channel at high tide. The commerce of the river is about 39,000 tons, but no substantial increase can be expected while the river remains in its present condition.

The city of Elizabeth has a population of about 33,000, and does an active commerce over two important lines of railroad, a considerable portion of which would take the water route to great advantage if adequate facilities existed. It is stated that the establishment of the coal-yard on the river has reduced the retail price of coal 50 cents per ton.

The expenditures for the fiscal year amount to $99.15 for office expenses.

July 1, 1889, amount available	$75.75
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	75.75
Amount appropriated by act of September 19, 1890	5,000.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	11,160.00

(See Appendix F 7.)

8. *Rahway River, New Jersey.*—In its original condition the Rahway River had a depth of 8 feet and more at mean high water from its mouth to Bricktown, 3⅝ miles; 7 feet to Edgar's Dock, 4⅛ miles; 4.4 feet to Milton Avenue Bridge, 4¾ miles; and 4 feet to Main Street Bridge, 5 miles, in the town of Rahway. Its commerce was estimated at 120,000 tons, and three attempts had been made to establish a line of steamboats on the river, but had failed on account of the bad condition of the stream.

The original project for its improvement was adopted in 1878, and provided for dredging a channel 125 feet wide and 8 feet deep at high water from Bricktown to Milton Avenue Bridge, and 100 feet wide from that point to Main Street Bridge. The tide rises about 5 feet at the mouth and 4 feet at the head of navigation.

June 30, 1889, $36,992.70 had been expended under this project, which had resulted in the formation of a channel 7 feet deep at high water, and from 100 to 50 feet in width to within 550 feet of the head of navigation. It has, however, not proved permanent.

The commerce of the river had not increased, though freight rates to Rahway had been materially reduced, as a result of the improvement of the river.

There has been no appropriation for this work since 1882.

The expenditures for the fiscal year amount to $7.30 for office expenses.

July 1, 1889, amount available	$7.30
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	7.30
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	29,250.00

(See Appendix F 8.)

9. *Raritan River, New Jersey.*—Before its improvement by the United States the Raritan River had a depth of 8.5 feet at "The Stakes," 3 miles; of 6.5 feet at the "Middle Grounds," 4½ miles; of 7.5 feet at Whitehead's Sand Dock, 8½ miles; and between this point and New Brunswick, 12¼ miles above the mouth, the channel was obstructed by a number of rocky shoals with depths of from 8.4 to 6.9 feet at mean low water. The city of New Brunswick and the Delaware and Raritan Canal, which terminates here, together with extensive brick-yards on the South River, did a large commerce on the stream, estimated in 1871 at 3,053,857 tons per annum.

The present project was adopted in 1874, and provides for obtaining by diking and dredging, and where necessary by drilling and blasting rock, a channel 200 feet wide and 10 feet deep mean low water, from the mouth to New Brunswick, at a cost of $2,093,662.05. It was modified in 1881 pursuant to the river and harbor act of that year by adding to it the dredging of the South Channel, about 13,000 feet long, 100 feet wide, and 5½ feet deep at mean low water, from Kearney's Dock to Crab Island.

Under this project $492,350.80 had been expended June 30, 1889, in construction of the dikes required by the project at "The Stakes" and "Middle Grounds," in dredging channels 200 feet wide and 12 feet deep at mean low water at these points, and in blasting and dredging a channel of the same dimensions across the rocky shoal at Whitehead's Sand Dock, and in carrying the channel with a width of 100 feet and depth of 10 feet, mean low water from this point to Martin's Dock, within 1⅝ miles of New Brunswick. Under the two special allotments made for it in the acts of March 3, 1881, and August 2, 1882, the south channel was dredged to the required depth for a distance of 4,000 feet. These improvements have been of great benefit to navigation, permitting the large tows in use on the river to reach a point 1⅝ miles below New Brunswick at all stages of the tide.

The expenditures during the fiscal year amounted to $18,334.59, with this amount the 10 foot, 100 feet wide, channel has been carried from Martin's Dock toward New Brunswick, a distance of 3,472 feet, and a shoal near Fox's Gully removed to a depth of 10 feet, mean low water, and width of 80 feet for a distance of 570 feet.

July 1, 1889, amount available		$27,713.59
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$17,148.98	
July 1, 1890, outstanding liabilities	1,424.27	
		18,573.25
July 1, 1890, balance available		9,140.34
Amount appropriated by act of September 19, 1890		50,000.00
Amount available for fiscal year ending June 30, 1891		59,140.34

Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	$1,522,412.05

(See Appendix F 9.)

10. *South River, New Jersey.*—Before the improvement of this stream was undertaken by the United States the navigation of the lower 2½ miles of its course had been abandoned and a canal dredged at private expense from a short distance below Washington to Sayreville on the Raritan River. In 1880, when the present project for improving the river was adopted, the mouth of this canal, on account of its faulty location, had shoaled to a depth of 4.6 feet at mean low water, and the best depth in the canal, some distance above, had decreased to 3.3 feet. Above Washington a depth of 2.7 feet existed to Bissett's, 3⅝ miles, and of 2.5 feet to Old Bridge, the head of navigation, 6¼ miles above the mouth of the canal at Sayreville.

The present project, adopted in 1880, provides for closing the river below the head of the canal, correcting the direction of the mouth of the latter, and obtaining by diking and dredging a depth of 8 feet, mean low water, to Washington, 6 feet to Bissett's, and 4 feet to Old Bridge, straightening the channel at two points by cutting across the meadow; it was estimated to cost $194,695.

The amount expended under this project to June 30, 1889, was $63,468.09, with which the direction of the mouth of the canal had been changed, the dikes below Washington completed, and a small amount of dredging done on a shoal above Washington. A shoal at the mouth of Washington Canal has been removed and a channel dredged 60 feet wide through the canal, and 50 feet wide across the shoal in the river below Washington. Vessels drawing 6 feet can reach Washington at mean low water.

No active operations have been carried on during the fiscal year, the United States dredging plant purchased in accordance with the approved project for the expenditure of the appropriation made in the act of August 11, 1888, being occupied in continuing the improvement of the Raritan River, and the amount of funds available being too small to admit of advantageous letting of the work to outside parties.

The condition of the river remains unchanged. The commerce of the river was valued in 1889 at $935,080. There has been a slight increase in the export of brick during the past year, two new brick-yards being in operation.

The expenditures during the fiscal year amounting to $558.33 have been for office expenses and an examination of the river, made in June, 1889, from the mouth to the bridge of the Raritan River Railroad Company.

July 1, 1889, amount available	$2,254.25
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	280.67
July 1, 1890, balance available	1,973.58
Amount appropriated by act of September 19, 1890	5,000.00
Amount available for fiscal year ending June 30, 1891	6,973.58

Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	123,695.00

(See Appendix F 10.)

11. *Shrewsbury River, New Jersey.*—When the present project for this improvement was adopted in 1879, the river was obstructed by a number of shifting sand-bars, which had caused the complete suspension of navigation in the South Branch, and only permitted the passage of vessels engaged in commerce up the North Branch at or near high water. A considerable trade was carried on, however, even under these difficult conditions.

The originally adopted project for the improvement was to dredge a channel 6 feet deep at mean low water, and from 300 to 150 feet in width across the shoals from the mouth to Red Bank, on the North Branch, 8 miles and Branchport on the South Branch, 9 miles; maintaining these channels by longitudinal dikes. This project has not been modified as to the end sought, but estimates of the diking, dredging, and cost, have been increased from time to time.

The amount expended on the project to June 30, 1889, was $210,233.45, which had resulted in the material improvement of the river, the commerce of which had been more than trebled since the commencement of the improvement.

The amount expended during the fiscal year ending June 30, 1890, was $4,059.43, with which the cross-over channel at Upper Rocky Point was dredged to a width of 100 feet and depth of 7 feet, mean low water; two shoals at Lower Rocky Point to a depth of 7 feet mean low water, and channel width of 240 feet, and a shoal in the west draw at the highlands bridge to a depth of 7 feet, mean low water, for a width of 60 feet, by the United States Dredging Plant.

July 1, 1889, amount available	$3,267.83
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$3,060.71
July 1, 1890, balance available	207.12
Amount appropriated by act of September 19, 1890	10,000.00
Amount available for fiscal year ending June 30, 1891	10,207.12
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	30,062.00

(See Appendix F 11.)

12. *Keyport Harbor, New Jersey.*—Keyport Harbor was originally accessible at low water only to vessels drawing less than 4 feet. Before its improvement was undertaken by the United States a 6-foot channel had been dredged at private expense, which had shoaled in 1872 to 5½ feet, and in 1882 to 5 feet, the range of the tide being 4.7 feet. A large commerce was carried on, however, valued at $2,932,000.

The project for the improvement was adopted in 1873, and provided for dredging a channel 4,700 feet long, 8 feet deep at mean low water, and 200 feet wide from the steam-boat dock to the 8-foot contour in Raritan Bay, at an estimated cost of $30,475. The revised estimate of 1884 was $40,475.

The amount expended under this project to June 30, 1889, was $30,333.72, with which a channel had been dredged from the 8-foot depth in Raritan Bay to Keyport Wharf, a distance of 5,000 feet, with a width of 200 feet for the first 4,200 feet and 160 feet for the remainder.

The expenditures for the fiscal year amount to $141.28 for office expenses.

The estimated increase of the commerce of this improvement, as compared with that reported in 1889, is about 1,000 tons.

July 1, 1889, amount available	$71.68
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	71.68
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	10,000.00

(See Appendix F. 12.)

IMPROVEMENT OF DELAWARE AND SCHUYLKILL RIVERS, AND OF RIVERS IN NEW JERSEY—HARBOR IMPROVEMENTS IN DELAWARE RIVER AND BAY—CONSTRUCTION OF PIER AT LEWES—DELAWARE BREAKWATER.

Officers in charge, Lieut. Col. Henry M. Robert, Corps of Engineers, to February 13, 1890; since that date Maj. C. W. Raymond, Corps of Engineers; Division Engineer since February 19, 1890, Col. Wm. P. Craighill, Corps of Engineers.

1. *Delaware River, Pennsylvania and New Jersey.*—Trenton, the head of natural navigation on the Delaware River, is about 30 miles above the upper part of the port of Philadelphia. In its original condition this part of the river was obstructed by shoals at the following localities: Between Bordentown and Trenton, a distance of about 5 miles, a narrow and circuitous channel existed, which carried from 3 to 6 feet at mean low water; at Kinkora Bar, about 9 miles below Trenton, a shoal carrying from 7 to 8 feet, and at Five-Mile Bar, at the upper part of Philadelphia, a shoal across the Pennsylvania channel carrying only 3 or 4 feet at mean low water, there being, however, 13 feet of water past Five-Mile Bar in the New Jersey channel, passing south of Petty's Island.

Below Philadelphia the river in its original condition presented obstructions at Mifflin Bar, which reduced the depth at mean low water to 17 feet, at Schooner Ledge and Cherry Island Flats to 18 feet, at Bulkhead Shoals and Dan Baker Shoal to about 20 feet.

In that part of the Delaware River between Trenton, N. J., and Bridesburg, Pa., efforts in the past have been directed toward relieving commerce from the obstructions which exist in the upper 9 miles of the river, or that part between Kinkora Bar and Trenton. A detailed survey of the river between Bridesburg and Trenton has been made for the purpose of obtaining the necessary data for determining upon a plan for the improvement of the river between Trenton and the upper part of Philadelphia to meet the requirements of commerce.

Previous to 1885 the efforts to improve the river between Philadelphia and the bay have been confined to dredging, except at Schooner Ledge, where solid rock has been removed, under appropriations for special localities, and also under general appropriations for the Delaware River below Bridesburg.

A Board of Engineers, convened by direction of the Secretary of War for the purpose of considering the subject of the permanent improvement of Delaware River and Bay, recommended, under date of January 23, 1885, the formation of a ship-channel from a point opposite Philadelphia and about midway between the American Shipbuilding Company's yard and the Gas Trust Wharf to deep water in Delaware Bay, having a least width of 600 feet and a depth of 26 feet at mean low water. The formation of such a channel is to be obtained, except at Schooner Ledge, where rock would require to be removed, by regulating the tidal flow by means of dikes, with recourse to dredging where

necessary as an aid to such contracting and regulating works. The estimated cost of obtaining a channel of the above dimensions is about $2,425,000, which covers the estimated cost of the permanent improvement of the Delaware River between the upper part of Philadelphia and deep water in the bay. This estimate of cost does not include the improvement of Philadelphia Harbor, which is a separate project. With the present requirements of commerce above Philadelphia it is not considered that the part of the river lying between Trenton and Bridesburg demands any improvement beyond the formation of a 12-foot navigable channel across Kinkora Bar, which is estimated at about $15,000.

The entire amount expended on the improvement of the Delaware River from 1836 to June 30, 1889, under appropriations both for special localities and the general river, was $1,825,874.16, of which $103,494.67 was expended on that part of the river between Trenton and the upper part of Philadelphia. As a result of this expenditure there had been formed at the latter date a channel of navigable width and 7½ feet deep at mean low water through the bars between Bridesburg and Bordentown; a channel across Five Mile Bar 8 feet deep, and past the bar between its southside and Petty's Island, a channel 9 feet deep; a channel from 200 to 400 feet wide and from 24 to 26 feet deep through the shoal areas at Port Richmond; a channel across Mifflin Bar 250 feet wide and from 24 to 26 feet deep; a channel through Schooner Ledge 330 feet wide and 24 feet deep, except over a small area discovered in 1889 where the depth is reduced to 23 feet at mean low water; a channel through Cherry Island Flats from 200 to 450 feet wide and from 24 to 26 feet deep, and a channel across Bulkhead Shoal 600 feet wide and from 20 to 21 feet deep.

The channel between Philadelphia and Camden, across Smith's Island Bar, had been improved by the formation of a dredged cut protected by revetment, so as to give a channel 100 feet wide with a minimum depth of 6 feet at mean low water.

During the fiscal year ending June 30, 1890, the sum of $117,067.62, which includes the liabilities outstanding June 30, 1889, was expended in surveys, examinations, and tidal observations; in dike construction at Five Mile Bar, and Reedy Island, in dredging at Port Richmond, and rock removal near Otis Street Wharf, Philadelphia, making a total expenditure since 1836 of $1,942,941.78 of which $590,941.78 has been expended on present project.

At Five Mile Bar a channel about 500 feet wide and 11½ feet deep at mean low water exists, which is the result of the action of the dike between Fisher's Point and Petty's Island.

At Port Richmond the extension of the 26-foot low-water channel, has been in progress by dredging, and at the close of the fiscal year the previously dredged channel, 450 feet wide, had been extended for a width of about 200 feet to a point about 1,500 feet above its upper termination in the previous fiscal year.

At the foot of Otis street, in the city of Philadelphia, where rock in place exists, 1,178 cubic yards were removed, thereby giving a depth of 26 feet at mean low water over the previous shoal area.

The dike at Mifflin Bar was completed to the plane of mean low water in 1888, except for a gap of 400 feet which serves as an entrance to the dumping-basin, and its action upon the channel dredged through the bar in the fall of 1888 shows that the effect of the dike, though manifest upon the bar, will probably have to be increased by raising the dike in the future to a greater height above the plane of mean low

water. The dredged channel across the bar now carries a depth of from 24 to 26 feet at mean low water in a channel from 150 to 250 feet wide.

At Bulkhead Shoal a channel 200 feet wide and 24 feet deep at mean low water was excavated across the worst part of the shoal in the fall of 1888, for the temporary relief of commerce. This dredged channel again quickly shoaled to about 20 feet at mean low water. The construction of dikes for the permanent improvement of Bulkhead Shoal will be commenced during the present season under a project approved May 15, 1890.

The dike at Reedy Island, which is intended for the improvement of Dan Baker Shoal, has not yet reached an extension sufficient to affect the areas it was designed to improve.

The channels at Schooner Ledge and Cherry Island Flats have remained unchanged during the year.

July 1, 1889, amount available		$100,058.83
July 1, 1889, amount covered by existing contracts		83,063.37
		183,122.20
July 1, 1890, amount expended during fiscal year exclusive of liabilities outstanding July 1, 1889	$114,063.98	
July 1, 1890, outstanding liabilities	115.95	
July 1, 1890, amount covered by uncompleted contracts made during the fiscal year ending June 30, 1890	9,003.30	
		123,183.23
July 1, 1890, balance available		59,938.97
Amount appropriated by act of September 19, 1890		250,000.00
Amount available for fiscal year ending June 30, 1891		309,938.97
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		1,715,000.00

(See Appendix G 1.)

2. *Harbor between Philadelphia, Pennsylvania, and Camden, New Jersey.*—In obedience to the requirements of the joint resolution of Congress, approved March 5, 1888, a Board of three engineers was appointed by the War Department "to examine and report in relation to the Delaware River between the City of Philadelphia, Pennsylvania, and Camden, New Jersey, and for other purposes," and its report was transmitted to Congress April 7, 1888, and printed as House Ex. Doc. No. 260, Fiftieth Congress, first session.

The plan of improvement proposed by the Board is the forming of a channel along the Philadelphia shore from opposite Kaighn's Point to opposite Fisher's Point, of ample depth and about 2,000 feet in width, at a distance from the present wharf-line such as to permit the extension of wharves and the widening of Delaware avenue at their shore ends, the removal of Smith's and Windmill islands and adjacent shoals, so as to give a 26-foot channel, about 1,000 feet wide, along the revised Philadelphia channel from opposite Kaighn's Point to the head of Petty's Island. The estimated cost of the work is $3,500,000 exclusive of the cost of the islands.

The river and harbor act of August 11, 1888, appropriated $500,000 for the work, of which not to exceed $300,000 is to be applied to the purchase of the islands.

During the fiscal year ending June 30, 1890, the legal proceedings for the condemnation of the islands were completed. The commissions appointed by the courts awarded the owners of Smith's and Windmill

islands the sum of $484,000, and of Petty's Islands $202,288.50; the legal costs of the condemnation proceedings were $22,364.36, making the aggregate cost of the islands $708,652.86.

In payment of this award the State of Pennsylvania appropriated $200,000, the city of Philadelphia $208,652.86, and the balance, $300,000, was provided from the appropriation of Congress in the river and harbor act of August 11, 1888. The payment of these amounts by the State, city, and General Government has been made, and the property taken deeded to the United States.

During the fiscal year ending June 30, 1890, $300,177.91 was expended in the purchase of the islands and in the preparation of a project for the application of the funds available for the commencement of the work.

Under the requirements of section 12 of the river and harbor act of August 11, 1888, a Board of engineer officers was constituted for the establishment of harbor lines for the port of Philadelphia, by Special Orders, No. 20, Headquarters Corps of Engineers, February 25, 1889, consisting of Cols. W. P. Craighill and C. B. Comstock, and Lieut. Col. H. M. Robert. Maj. C. W. Raymond, having relieved Lieut. Col. H. M. Robert of the charge of the district, was made a member of the Board in his place. This Board has not yet completed its duties.

July 1, 1889, amount available		$500,000.00
July 1, 1890, amount expended during fiscal year ($300,000 of which applied to purchase of lands), exclusive of liabilities outstanding July 1, 1889	$300,177.91	
July 1, 1890, outstanding liabilities	1.50	
		300,179.41
July 1, 1890, balance available		199,820.59
Amount appropriated by act of September 19, 1890		200,000.00
Amount available for fiscal year ending June 30, 1891		399,820.59
Amount (estimated) required for completion of existing project		3,100,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892		1,000,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix G 2.)

3. *Schuylkill River, Pennsylvania.*—When the work of improvement was commenced in 1870 there was a channel of entrance into the mouth of the river carrying a depth of only 10 feet at mean low water.

The original project under which work was commenced in 1870 proposed the formation of a channel 100 feet wide with a depth of 20 feet from the mouth of the river to Gibson's Point, about 4 miles, and a depth of 18 feet from thence to Chestnut Street Bridge in Philadelphia, about 3 miles.

In 1875 and 1883 this project was amended so as to increase the low-water channel between the mouth and Girard Point, a distance of about 1 mile, to 400 feet wide and 24 feet deep, and from Girard Point to Gibson's Point, about 3 miles, to 250 feet wide and 20 feet deep.

The amount expended upon these projects to June 30, 1889, was $393,381.63, and had resulted in the formation of a channel as follows: Between the mouth and Girard Point Piers the minimum channel was 150 feet wide and from 18 to 19 feet deep at mean low water; from Girard Point to Gibson's Point the channel was 250 feet wide and 20 feet deep, except for about three-fifths of a mile directly above Penrose Ferry Bridge where the 20-foot channel was only 100 feet wide; from

Gibson's Point to Chestnut Street Bridge the channel was of navigable width and 18 feet deep at mean low water. This latter reach of river has required no other improvement than the removal of about 1,000 cubic yards of rock near Locust and South streets.

During the fiscal year ending June 30, 1890, $146.02 was expended upon office expenses.

July 1, 1889, amount available	$368.37
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	146.02
July 1, 1890, balance available	222.35
Amount appropriated by act of September 19, 1890	45,000.00
Amount available for fiscal year ending June 30, 1891	45,222.35
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	46,250.00

(See Appendix G 3.)

Ice-Harbor at Marcus Hook, Pennsylvania.—This work in its present plan was commenced in 1866, the object being to provide a harbor in the Delaware River to protect vessels against moving ice.

In 1785 the Commonwealth of Pennsylvania built, for the convenience of commerce, piers at Marcus Hook extending from the shore-line into the river. It is assumed that at some subsequent time these shore-piers were turned over to the United States, since in 1829 an appropriation was made of $5,000 for repairing these piers, improving the harbor, and removing obstructions. No further appropriation was made until 1866.

At this latter date the project was adopted for the construction of detached piers in the harbor, consisting of stone superstructures upon crib foundations filled with stone, together with the deepening of the harbor by dredging.

In 1881 it was proposed to increase the area of the harbor by the construction of a bulkhead about 1,800 feet in length parallel to the shore-line, and about 150 feet outside of high-water line, and the deepening of this added area by dredging.

Nothing was done towards the carrying into effect of the modification of 1881, on account of the unwillingness of some of the abutting property owners, and in 1888 this hitherto proposed modification was abandoned and an increased depth proposed for the areas protected by the detached piers outside of the natural shore-line of the river.

The amount expended from 1866 to June 30, 1889, was $208,345.89, and resulted in the construction of two shore or landing piers, and seven detached ice-piers, the deepening by dredging of the area protected by the piers, and the placing of mooring piles within the harbor. By this expenditure a harbor was formed with an area of about 10 acres, carrying a depth of from 12 to 25 feet at mean low water.

During the fiscal year ending June 30, 1890, $152 was expended upon office expenses.

July 1, 1889, amount available	$654.11
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	152.00
July 1, 1890, balance available	502.11
Amount appropriated by act of September 19, 1890	5,000.00
Amount available for fiscal year ending June 30, 1891	5,502.11

(See Appendix G 4.)

5. *Ice-harbor at head of Delaware Bay, Delaware.*—The act of August 2, 1882, appropriated $25,000 for the commencement of work on the ice-harbor at the head of Delaware Bay, to include the removal of some sunken piers, the remains of an old ice-harbor, in the channel east of Reedy Island, Delaware.

The desirability of an ice-harbor at the head of Delaware Bay has been long recognized, but until the improvement of the main ship-channel shall have been materially advanced it is believed that appropriations can be applied, with better results to commerce, to the improvement of the channel rather than to the formation of an ice-harbor suited to the requirements of the case. As to location, the prevailing judgment would place the ice-harbor at or very near Liston's Point. The plan of construction hitherto proposed in general terms provided for a nearly inclosed area by means of a barrier to protect vessels against moving ice. This barrier was to consist of iron piles placed at intervals and connected with an iron superstructure so arranged as to either hold or ward the ice from the area within the barrier. The cost of such an ice-harbor has been variously estimated at from $400,000 to $600,000.

The amount expended to June 30, 1889, was $8,723.07, of which $3,700 was applied to the removal of the sunken piers back of Reedy Island, as provided in the act of August 2, 1882, making the appropriation of $25,000. The balance was expended in surveys, examinations, and preliminary studies.

During the fiscal year ending June 30, 1889, nothing was expended:

July 1, 1889, amount available	$16,276.93
July 1, 1890, balance available	16,276.93

(See Appendix G 5.)

6. *Construction of iron pier in Delaware Bay, near Lewes, Delaware.*—The original project for this work proposed the construction of a landing-pier about 1,700 feet in length, extending from the shore south of the breakwater into Delaware Bay to a depth of 22 feet at mean low water, the pier to consist of a substructure of wrought-iron screw-piles surmounted with a timber superstructure. The work was commenced in 1871, and completed, except as to superstructure, in 1880.

The amount expended to June 30, 1889, was $368,375.06, and resulted in the construction of 1,155 linear feet of pier 21 feet in width, and 546 linear feet 42 feet in width, or a total length of 1,701 feet. The depth of water at the outer end of the pier-head was about 21 feet at mean low water.

During the gale of March 12, 1889, five of the wrought-iron screw-piles were injured by the collision of a wrecked schooner. On September 13, 1889, twelve additional piles were injured by the collision of a wrecked bark. About 200 linear feet of the pier is involved in these injuries. The cost of the repair was estimated at $10,000, and to provide therefor an appropriation of this amount was made by act of April 4, 1890.

It is proposed to repair the pier by removing the 17 injured wrought-iron screw-piles and replacing them with cast-iron columns bolted to timber sills which are sunk below the action of scour, after which the timber superstructure covering the injured part of the pier will be restored upon its original plan. To provide against similar accidents to the pier from colliding vessels or wrecks fender-piles will be placed along both sides of the shore-arm of the pier.

During the fiscal year ending June 30, 1890, $78.60 was expended in the preparation of plans for the repair of the pier.

From the decayed condition of the timber superstructure it is not available for use by the railroad to which the right was given to use the pier under the provisions of the act of July 15, 1870.

If the pier is to be rendered available for the general purposes of railroad traffic, as contemplated in the act above referred to, it will be necessary to replace the present decayed wooden superstructure by an iron construction, which has been estimated at $93,000.

July 1, 1889, amount available	$124.94
Amount appropriated by act of April 4, 1890	10,000.00
	10,124.94
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	78.60
July 1, 1890, balance available	10,046.34

(See Appendix G 6.)

7. *Delaware Breakwater Harbor, Delaware.*—Under act of Congress, May 7, 1822, $22,700 was appropriated for a survey of Delaware Bay, near Cape Henlopen, for the purpose of determining upon the site for a harbor of shelter. In 1828 an appropriation of $250,000 was made for commencing the work under a plan submitted by a board of commissioners appointed by Congress.

The project of the board contemplated the construction in the concavity of the bay, just inside Cape Henlopen, of two massive works on the pierres perdues or riprap system, separated by an interval or gap of 1,350 feet—the greater, called the breakwater, to afford safe anchorage during gales from the north and east; the other, called the ice-breaker, to protect shipping against northwesterly gales and the heavy drifting ice of the bay.

This project was completed in 1869, under aggregate appropriations, including the first for survey, of $2,192,103.70. The stone used in the work amounted to 892,528 gross tons, and varied from one-quarter of a ton to 7 tons in weight, the smaller constituting the bulk of the mass, the larger used to cover the exterior slopes.

As completed in 1869 the breakwater is 2,558 feet long, and the ice-breaker 1,359 feet long on top. The average width on top is 22 feet and at base 160 feet. The top is from 12 to 14 feet above mean low water.

In 1882 a project was adopted for closing the gap between the breakwater and the ice-breaker by means of a random stone foundation with a concrete superstructure. The random stone foundation was to be brought to a height of 12 feet below low water, with a width on top of 48 feet. The concrete superstructure to have a width on bottom of 24 feet, rising to a height of 12 feet above mean low water, with a width on top of 12 feet. The estimated cost of this project was $675,000.

In 1883 and 1884 the project was modified by providing a foundation of brush mattresses for the random-stone superstructure and omitting the construction of a pile-bridge across the gap, which formed part of the project of 1882 for closing the gap.

In 1890 the concrete superstructure was further modified by establishing its base at 15 feet below mean low water, by making it rectangular in section, with a width of 27 feet and height of 27 feet, and by constructing the work to above the plane of high water of large concrete blocks, above which concrete in mass is to be used. The estimated cost of the modified project, including the $356,250 appropriated from 1882 to 1888, was $856,250.

From the beginning of the work in 1822 to June 30, 1889, the total

amount expended was $2,498,400.35, of which $306,296.65 was expended on the project of 1882 for closing the gap.

During the fiscal year ending June 30, 1890, $48,725.57 was expended in the formation of the random-stone substructure for the work, which is intended to close the gap between the breakwater and ice-breaker. The total expenditure to June 30, 1890, has been $2,547,125.92, of which $355,022.22 has been under present project.

The increase in the dimensions and draught of vessels since the present harbor was designed in 1822, together with the shoaling which has ensued behind the breakwater, renders the present harbor under these changed conditions inadequate for the requirements of commerce. Upon the completion of the present project of closing the gap, additional anchorage area will be added to the harbor and make it of great and continued value to coasting vessels.

July 1, 1889, amount available		$5,075.72
July 1, 1889, amount covered by existing contracts		39,705.15
		44,780.87
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$43,649.85	
July 1, 1890, outstanding liabilities	74.43	
		43,724.28
July 1, 1890, balance available		1,153.35
Amount appropriated by act of September 19, 1890		80,000.00
Amount available for fiscal year ending June 30, 1891		81,153.35
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		420,000.00

(See Appendix G 7.)

8. *Mantua Creek, New Jersey.*—The original project for this improvement contemplates the construction of a low-water channel 10 feet deep and 80 feet wide at the mouth of the creek, which is to diminish to 4 feet in depth and 40 feet in width at the town of Mantua, situated some 11 miles from the mouth, at an estimated cost of $35,000.

The stream in its natural condition, as shown by the survey of 1881, had at its mouth (one-fourth mile outside the high-water line) 8 feet at mean low water and nearly that depth at a second bar one-half mile up the stream. If these two bars had been improved, there would have been a 9-foot channel up to a bar 1½ miles from the mouth, where there was a maximum depth of 7 feet. The lower 1½ miles of the stream can not safely be said to have had in its natural condition in 1881 a navigable channel with a greater depth than 7½ feet, while there was a navigable channel with 6½ feet for 4½ miles farther, and thence to Mantua, 11 miles from the mouth, a channel gradually diminishing to 2 feet.

At the request of parties interested in the lower part of the river the lower one-half mile was resurveyed in 1889. This survey indicated that a shoaling of from 1 to 2 feet had occurred during the last eight years. At one point in the channel of navigable width there is only 5 feet of water. The officer then in charge recommended the expenditure of the $3,000 appropriated August 2, 1882, in dredging a channel with a least width of 60 feet and a least depth of 8 feet at mean low water from the mouth up to the phosphate works, a distance of about one-half mile.

The amount expended during the fiscal year ending June 30, 1889, was $84.34 which was applied to a survey of the creek.

During the fiscal year ending June 30, 1890, $2,915.66 was expended

in the formation, by dredging, of a channel from 60 to 75 feet wide from the mouth to the phosphate works, half a mile above.

July 1, 1889, amount available	$2,915.66
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	2,915.66

(See Appendix G 8.)

9. *Removal of wrecks from Delaware Bay and River.*—During the past fiscal year no wrecks have been removed under this appropriation.

July 1, 1889, amount available	$758.62
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	24.54
July 1, 1890, balance available	734.08

(See Appendix G 9.)

10. *Removing sunken vessels or craft obstructing or endangering navigation.*—During the past fiscal year the following wrecks were removed under the provisions of the act of June 14, 1880: The bark *Patriot*, barges *Tonawanda*, *Wallace*, *Casilda*, and *St. Cloud*, and the bark *Il Salvatore* from Delaware Bay.

(See Appendix G 10.)

EXAMINATION AND SURVEY FOR IMPROVEMENT, TO COMPLY WITH REQUIREMENTS OF RIVER AND HARBOR ACT OF AUGUST 11, 1888.

It appearing from the preliminary examination made by the local engineer that *Alloway Creek*, *New Jersey*, is worthy of improvement, and the public necessity therefor being apparent from the facts and reasons reported, which are concurred in by the Chief of Engineers, Lieutenant-Colonel Robert was charged with and completed its survey, the results of which were transmitted to Congress and printed as House Ex. Doc. No. 60, Fifty-first Congress, first session. (See also appendix G 11.)

IMPROVEMENT OF HARBORS AND RIVERS IN THE STATES OF DELAWARE AND MARYLAND, AND OF MAURICE RIVER, NEW JERSEY, AND OF THE INLAND WATER-WAY FROM CHINCOTEAGUE BAY, VIRGINIA, TO DELAWARE BAY.

Engineer in charge, William F. Smith, United States Agent, Major of Engineers, U. S. Army, Retired; Division Engineer, Col. W. P. Craighill, Corps of Engineers.

1. *Maurice River, New Jersey.*—This stream has, with the exception of the bar at the mouth, over which there is 5 feet of water at mean low tide, a natural channel from 10 to 40 feet deep extending from its junction with the Delaware Bay to Ferguson's Dock, 4 miles below Millville, a distance of about 20 miles. Near this dock the 6-foot curve formerly closed and the remainder of the river was quite shoal with minimum depths of 2 feet.

The adopted project is based upon a survey made in 1881, and provides for a 6-foot low-water channel 100 feet wide to Millville Bridge, and for a 4-foot channel of the same width above the bridge to the head of navigation. The original estimated cost of dredging this channel was $112,000, at 35 cents per cubic yard.

At the beginning of the past fiscal year the improved channel had been extended from below to a point about 1 mile below Millville to the full width of 100 feet. A narrow channel from 50 to 75 feet wide had

been made in continuation of the former to 400 feet above the bridge in the town.

The total amount expended in the improvement up to the close of the fiscal year ending June 30, 1889, was $25,008.93.

During the past fiscal year an agreement was made with the American Dredging Company, of Philadelphia, for the expenditure of the available funds in dredging at 15 cents per cubic yard, measured in place. The money is being expended in the further extension of the improved channel towards the head of navigation. At the close of the fiscal year 49,918 cubic yards of material had been removed, dredging operations having been commenced on May 6, 1890, and the channel had been extended 4,000 feet.

The amount expended during the fiscal year ending June 30, 1890, is $3,807.90. The work under the present agreement will be completed early in July, 1890.

It is stated that the commerce of the river has more than doubled since a larger class of vessels have been able to reach, without interruption by low tides, the wharves at Millville, which is a manufacturing center of considerable importance.

July 1, 1889, amount available		$9,991.07
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$3,807.90	
July 1, 1890, outstanding liabilities	4,204.77	
		8,012.67
July 1, 1890, balance available		1,978.40
Amount appropriated by act of September 19, 1890		8,000.00
Amount available for fiscal year ending June 30, 1891		9,978.40
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		69,000.00

(See Appendix H 1.)

2. *Wilmington Harbor, Delaware.*—In the year 1836, when the first appropriation for the improvement of the Christiana River was made, the depth of water at low tide was from 8 to 9 feet at the entrance in the Delaware River, and about 8 feet at the shoalest place below the Third Street Bridge. The depth in the channel was increased that year to 10 feet by dredging.

In 1871 a more comprehensive project was made to dredge a channel 12 feet in depth from the mouth to above the city of Wilmington. This project was completed in 1881. A new project was submitted in 1881 by a Board of Engineers and approved, for a 15-foot channel as far as the Pulp Works, and a 12-foot channel to the Delaware Railroad Bridge above, and for the construction of a jetty at the mouth of the river, the whole improvement estimated to cost $175,551. The dimensions of the proposed channel were somewhat changed in 1883, and the estimated cost increased to $191,384, exclusive of the cost of the jetty, which was then nearly completed. In the following year the project was amended to provide for an additional height of 4 feet to the jetty and to extend its length 322 feet.

Up to the close of the fiscal year ending June 30, 1889, the sum of $257,230.01 had been expended.

A contract was entered into in August, 1889, for dredging, at 13.9 cents per cubic yard, the channel in the Christiana River to a width of 150 feet and 15 feet deep at low water, beginning at the corresponding depth in the Delaware River and as far up as the available funds would

permit. Work under this contract was commenced on August 26, and ceased December 9, 1889, 165,214 cubic yards of material having been removed. The channel dredged extended from the Delaware River to the Shell Pot Bridge, a total distance of 7,200 feet; a smaller cut, 80 feet wide and about 900 feet long, was also dredged through and beyond the north draw of the bridge until it intersected the main channel above. The jetty was repaired during the month of October, 1889, under contract with Ira Lunt, at an expense of $1,463.67.

The amount expended during the fiscal year ending June 30, 1890, is $27,129.21.

July 1, 1889, amount available	$29,964.77
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	27,129.21
July 1, 1890, balance available	2,835.56
Amount appropriated by act of September 19, 1890	30,000.00
Amount available for fiscal year ending June 30, 1891	32,835.56
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	87,634.00

(See Appendix H 2.)

3. *Ice Harbor at New Castle, Delaware.*—The ice harbor at New Castle is one of the eldest in the Delaware River, its construction for the protection of shipping against ice having been commenced during colonial times. Since the beginning of the present century its improvement has been carried on by the General Government at intervals, the total amount expended at the close of the fiscal year ending June 30, 1889, being $223,183.94.

The sum of $153.56 was expended during the fiscal year ending June 30, 1890, in making an examination of the harbor and ice piers.

The present project is to rebuild one of the ice-piers in the harbor which it is estimated will cost $15,600. The balance available of the appropriation of August 11, 1888, is, therefore, still left unexpended until a sufficient sum is appropriated to begin the work.

July 1, 1889, amount available	$7,500.00
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	153.56
July 1, 1890, balance available	7,346.44
Amount appropriated by act of September 19, 1890	8,100.00
Amount available for fiscal year ending June 30, 1891	15,446.44

(See Appendix H 3.)

4. *Duck Creek, Delaware.*—In the year 1879, before improvements were commenced, there was a minimum depth of 2½ feet in the creek and of 4 feet over the bar at the mouth at mean low water. Navigation was possible only at high water and was carried on by one steamer and seven sailing vessels of the smaller class.

A survey and project was made in 1878 for the improvement of the creek which included a plan for deepening the channel across the bar at the mouth. By special direction of Congress the latter portion of the project was commenced first, and during the following four years appropriations of an aggregate amount of $10,000 were made for that purpose. A channel was dredged across the bar 100 feet wide and 8 feet deep at low water; but it soon filled up again.

A second survey of the creek was made in 1887 and a new project

submitted. It is for a 7-foot low-water channel 60 feet wide inside the creek, and for a channel of the same depth and 100 feet wide across the bar at the mouth, with stone jetties on either side to protect it; the total cost being estimated at $90,698.40.

The appropriation of $10,000 made by the act of August 11, 1888, was by special limitation expended in dredging and on that portion of the project which relates to the improvement inside the creek. A channel 40 feet wide and 6½ feet deep at low water was dredged during the fiscal year ended June 30, 1889, from Smyrna Landing to Brick Store Wharf, a distance of 3 miles. Vessels can now navigate the creek to a point 2 miles above the former highest landing and the principal shipping point has been brought that much nearer the center of the surrounding farming region.

No work was done during the past fiscal year.

July 1, 1889, amount available	$89.72
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	89.72
Amount appropriated by act of September 19, 1890	*5,000.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	22,365.00

(See Appendix H 4.)

5. *St. Jones River, Delaware.*—Before the channel was improved the least practicable depth of water to Lebanon, 12 miles above the mouth, was 4 feet; to Dover, 9 miles further up the river, only 2½ feet at mean low water.

The original project made in 1880, was for a 3-foot low-water channel 100 feet wide, across the bar at the mouth, protected by a jetty, at an estimated cost of $35,000. A project was added in 1884 and approved, to include the removal of shoals in the river to a depth of 6 feet at mean low water. Improvements were not begun until 1885. The proposed channel within the river was reported as nearly completed at the close of the fiscal year ending June 30, 1888, $25,000 having been expended. A modification of the project for the improvement of the entrance was submitted in March, 1889, which was approved, as was also a proposition to make a cut-off at a very sinuous bend in the river near Wharton's Fishery.

At the beginning of the fiscal year ending June 30, 1890, contract had been made for the expenditure of the appropriation of $15,000 made August 11, 1888, in carrying out the project for the improvement of the entrance and at Wharton's Fishery.

Operations were commenced August 1 and ended December 31, 1889. The total amount of material removed by the contractor was 58,015 cubic yards.

During the fiscal year ending June 30, 1890, the sum of $14,097.64 has been expended. The results are a channel 6 feet deep at low water across the bar at the mouth and nearly 100 feet wide, flanked on each side by banks of hard material removed from the cut; a new cut-off, 900 feet long and 40 feet wide at a bend in the river 2 miles below Lebanon; and the removing of two small shoals at Lea's Landing and Broad Reach, respectively.

There now exists a clear and unobstructed 6-foot low-water channel, 40 feet wide within the river and nearly 100 feet wide over the bar at

*This amount was appropriated by act of September 19, 1890, for improving Smyrna River, Delaware, continuing improvement.

the mouth, from Dover to deep water in Delaware Bay. The improvements, which up to the close of the fiscal year ending June 30, 1890, have cost $39,509.84, may be reported as completed in accordance with the various projects, and no further appropriation is recommended.

July 1, 1889, amount available	$2,688.16
July 1, 1889, amount covered by existing contract	11,900.00
	14,588.16
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	14,097.64
July 1, 1890, balance available	490.52

(See Appendix H 5.)

6. *Mispillion Creek, Delaware.*—The entrance to this creek has a mean low-water depth of only 1½ feet. Within the stream the original depth of water in the shoalest sections was from 4 to 5 feet. The original project is for a 6-foot low-water channel 40 feet wide from Milford, at the head of navigation, to the mouth of the creek. This project was begun in 1879 and since then $17,000 have been expended thereon, resulting in an unobstructed channel 6 feet deep at mean low water and not less than 40 feet wide throughout that section situated between Milford and Flat Reach Shoal near the mouth of the creek, a distance of 12 miles. The last named shoal remains to be dredged to complete the present project.

Nothing was done on the creek during the fiscal year ending June 30, 1890, for want of funds.

Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	$2,000.00

(See Appendix H 6.)

7. *Broadkiln River, Delaware.*—In its original condition the depth of water in the river was from 3 to 4 feet at the numerous shoals which impeded navigation. At the entrance the depth was, and still is, only from 1½ to 2 feet.

A project for a 6-foot low-water navigation inside the river from the mouth to Milton and for a new entrance across Lewes Cape, was adopted in 1871, and since then the execution of that portion of the project relating to the improvement of the river proper has been in progress.

Up to the close of the fiscal year ending June 30, 1889, the sum of $25,408.79 had been expended for this river. The 6-foot channel as proposed was then completed from Milton to Green Island or to within 1½ miles of the mouth, and the improvement has resulted in an increase in shipping. During the past fiscal year contract was made for dredging the remaining portion of the river from Green Island to the mouth, to the required depth and width. At the close of the fiscal year 20,972 cubic yards of material had been removed and a channel 4,690 feet long had been made.

It is estimated that the money now being expended will complete the proposed channel inside the river.

The sum of $714.40 was expended during the fiscal year ending June 30, 1890.

It is recommended for the present that further action in carrying out the existing project for the improvement of the mouth be postponed. The near probability of the opening of a new outlet not far from the mouth of the Broadkiln River, for the canal now being constructed

between Chincoteague Bay and Delaware Bay, may call for a modification of the present project.

July 1, 1889, amount available		$9,591.21
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$714.40	
July 1, 1890, outstanding liabilities	1,297.87	
July 1, 1890, amount covered by uncompleted contracts made during the fiscal year ending June 30, 1890	6,531.96	
		8,544.23
July 1, 1890, balance available		1,046.98
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		21,500.00

(See Appendix H 7.)

8. *Inland water-way from Chincoteague Bay, Virginia, to Delaware Bay, at or near Lewes, Delaware.*—This improvement is made with the view of forming an inland navigation route about 75 miles in length between Chincoteague Bay, Virginia, and Delaware Bay.

The project contemplates a "dead level" tidal canal, 6 feet deep below mean low water in the Delaware Breakwater Harbor, and 70 feet wide at the bottom, beginning at the head of Chincoteague Bay, following deep water in Sinepuxent, Isle of Wight, and Assawoman bays, then dredged across the high land near Ocean View, Delaware, to Indian River Bay, thence across this bay and Rehoboth Bay, and the high land intervening between the head of Rehoboth Bay and the shore of Delaware Bay at or near Lewes, Delaware, into the harbor of the Delaware Breakwater. The estimated cost is $350,000.

Two appropriations prior to act of September 19, 1890, have been made for this work; one of $18,750, by act of August 5, 1886, and one of $50,000, by act of August 11, 1888. By direction of Congress both were to be expended upon the section of the route which lies between Chincoteague Bay and Indian River Bay. In accordance with this proviso a project for a cut from Assawoman Bay to Indian River Bay, about 4 miles in length and 2 feet in depth, with a width at the base of the cut of 20 feet, was made and approved. The depth was subsequently increased to 4 feet below mean level of Assawoman Bay. Under contract with C. McLean, of New York, operations have been in progress since February, 1889. Owing to many unexpected delays and obstacles encountered by the contractor in the prosecution of the work, the time for the completion of the contract has been extended three times, the last time until August 1, 1890.

The amount of material excavated during the fiscal year ending June 30, 1890, was 46,838 cubic yards, making a total of 110,828 cubic yards removed since operations were commenced.

About 1 mile of the cut and beginning at the 4-foot depth in Assawoman Bay is finished to the specified dimensions. The remainder may average 2 feet in depth.

A contract has been entered into for the construction of three temporary bridges across the cut now being excavated at points where public roads cross the latter. The bridges are now being constructed and presumably will be completed by August 1, next.

The amount expended up to the close of the fiscal year ending June 30, 1889, was $12,386.81.

The amount expended during the fiscal year ending June 30, 1890, was $10,632.53.

July 1, 1889, amount available		$22,270.62
July 1, 1889, amount covered by existing contract		31,823.78
		54,094.40
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$10,632.53	
July 1, 1890, outstanding liabilities	3,804.82	
July 1, 1890, amount covered by existing and uncompleted contracts made during the fiscal year ending June 30, 1890	24,602.36	
		39,039.71
July 1, 1890, balance available		15,054.69
Amount appropriated by act of September 19, 1890		50,000.00
Amount available for fiscal year ending June 30, 1891		65,054.69
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		231,500.00

(See Appendix H 8.)

9. *Broad Creek, Delaware.*—The original depth in Broad Creek directly below the Delaware Railroad Bridge was on an average 1½ feet; above the bridge it was 2 feet. At some points there were minimum depths of only 6 inches at low water. The rise and fall of the tide was in consequence very small.

The original project, made in 1880, proposed a 7-foot low-water channel 60 feet in width and extending to the head of navigation at Laurel, Del., at an estimated cost of $46,500; if wing-dams and training-walls were added, the estimate would be increased to $60,000.

This project was modified in 1883 by reducing the proposed channel-depth to 6 feet and the width to 50 feet; the amount required to complete this project was then estimated at $32,625, which included the cost of 10,000 feet of diking.

At the close of the fiscal year ending June 30, 1889, the sum of $30,021.75 had been expended and the channel as projected was nearly completed.

During the fiscal year ending June 30, 1890, the sum of $4,978.25 was expended in dredging between the railroad bridge and the turning basin at Laurel and in removing a shoal, made by freshets, just below the railroad bridge and several projecting points in the banks of the creek near Hitch's Wharf, 2 miles below Laurel. Nineteen thousand nine hundred and eighty seven cubic yards of material were removed. The expenditure of this money completes the improvement of Broad Creek in accordance with the present project.

July 1, 1889, amount available	$728.25
July 1, 1889, amount covered by existing contract	4,250.00
	4,978.25
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	4,978.25

(See Appendix H 9.)

10. *Susquehanna River, above and below Havre de Grace, Maryland.*—Before improvements were commenced in this section of the river the least depth of water over the shoals between Havre de Grace and Spesutia Island was 5 feet at mean low water. The channel between Watson's Island, above Havre de Grace, and the shoal running out from the

west shore was very narrow and caused many serious ice gorges at and near Port Deposit.

The improvements have been in progress since 1852. The present general project is for a 15-foot low-water channel below Havre de Grace and for the removal to a depth of 8 feet of the shoal opposite Watson's Island.

The channel below Havre de Grace was dredged the last time in 1885 to a depth of 12 feet; it has shoaled again. The channel west of Watson's Island has been widened by dredging about 400 feet.

At the close of the fiscal year ending June 30, 1889, $148,911.35 had been expended on this improvement. The sum of $9,606.40 was expended during the fiscal year ending June 30, 1890. The shoal opposite Watson's Island was dredged in accordance with the present project. Operations were commenced on July 8, and ended August 17, 1889, and 47,978 cubic yards of material were removed. By direction of the Chief of Engineers, a survey of the river from Port Deposit to Spesutia Island was made during November, 1889, and a copy of the chart of the survey was forwarded in the following month.

July 1, 1889, amount available	$1,478.65
July 1, 1889, amount covered by existing contract	8,500.00
	9,978.65
July 1, 1890, amount expended during fiscal year exclusive of liabilities outstanding July 1, 1889	$9,606.40
July 1, 1890, balance available	372.25
Amount appropriated by act of September 19, 1890	4,000.00
Amount available for fiscal year ending June 30, 1891	4,372.25
Amount (estimated) required for annual dredging. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	20,000.00

(See Appendix H 10.)

11. *Fairlee Creek, Maryland.*—The original depth at the mouth before improvement was commenced was 2 feet. Inside the creek it is 5 feet at mean low water.

Navigation is carried on by a few flat-bottomed, so called, lime boats and one schooner. The existing project of improvement is for a 7-foot low-water channel 100 feet wide across the bar and inside the creek, for a total distance of nearly 3 miles, at an estimated cost of $15,558.

An appropriation of $5,000, made by the river and harbor act of August 11, 1888, being the first one made for this improvement, was exhausted during the fiscal year ending June 30, 1889, and a cut was made across the bar at the mouth 80 feet in width and about 900 feet long and of the required depth. It is not known what the present condition of this cut is, but it was expected that it would soon fill up again.

As yet, there is no appreciable benefit to be reported upon the very limited commerce of the creek.

Nothing was done here during the fiscal year ending June 30, 1890.

July 1, 1889, amount available	$309.31
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	309.31
Amount appropriated by act of September 19, 1890	5,000.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	5,558.00

(See Appendix H 11.)

12. *Corsica Creek, Maryland.*— Before improvements were made there was an ample depth of water in this stream as far as Hooper's Landing, about 4½ miles above the mouth. From there to the head of navigation at Centreville the depth was 8 feet and the channel very narrow.

The original project, adopted in 1882, provided for a channel 100 feet wide and 8 feet deep at mean low water from the above landing to the bridge at Centreville, including a turning basin at the latter place, at an estimated cost of $30,000.

The sum of $29,405.59 had been expended at the close of the fiscal year ending June 30, 1889, including outstanding liabilities. During the past fiscal year $594.41 were expended.

The result is the completion of the channel in accordance with the original project and no further appropriation is recommended.

July 1, 1889, amount available	$594.41
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	594.41

(See Appendix H 12.)

13. *Choptank River, Maryland.*—At the time the project for the improvement of this river was made, in 1879, the depth of water between Denton and Greensborough varied from 2 to 8 feet at low water. Navigation by small sailing vessels extended to 3 miles above Denton. Above that point and for a distance of 5 miles, lighters were used for the transportation of freight to the lower landing-places

A project was made in 1880 for an 8-foot low water channel 75 feet wide, at an estimated cost of $79,000. During the three following years the channel was dredged to a depth of only 6 and 7 feet on account of the small appropriations made and the high prices for dredging. Since 1885 the originally proposed depth has been made whenever possible and the width restricted to 40 feet.

Up to the close of the fiscal year ending June 30, 1889, the sum of $30,076.26 had been expended, and the least depth in the improved channel from Denton to Case's Wharf, was 5 feet, a sufficient gain to warrant the establishment of a steam-boat line for freight with Baltimore, which now runs regularly.

The appropriation of $7,500 made by the act of August 11, 1888, had been withheld on account of the excessive bids previously received, until February, 1889, when an agreement was made with the American Dredging Company of Philadelphia for continuing dredging as proposed, at 15 cents per cubic yard. Operations were commenced on June 25, 1890, and it is expected will be completed in August following.

At the close of the fiscal year 1,970 cubic yards of material had been removed and the proposed channel, 40 feet in width, had been extended to a point 222 feet above where the work terminated in 1888 at Case's Wharf. The amount expended during the fiscal year ending June 30, 1890, is $61.36.

It is stated that an additional steam-boat line will be started at the close of this season's work.

July 1, 1889, amount available		$7,423.74
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$61.36	
July 1, 1890, outstanding liabilities	295.50	
		356.86
July 1, 1890, balance available		7,066.88
Amount appropriated by act of September 19, 1890		7,500.00
Amount available for fiscal year ending June 30, 1891		14,566.88

Amount (estimated) required for completion of existing project..... Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	$23,000.00

(See Appendix H 13.)

14. *Cambridge Harbor, Maryland.*—The entrance to this harbor was originally only 4½ feet deep at mean low tide at the shoalest place. The average depth in the harbor was about 3 feet; at a few points it was 8 and 9 feet. Strong northwesterly winds often made the bar impassable for vessels drawing 3 feet. The local commerce was in consequence carried on by a limited number of sailing-vessels of the smallest class and by one steamer of light draft. Improvements were commenced in 1871 and completed in 1879, in accordance with the original project, the result having been a channel 100 feet wide across the bar and an increase of anchorage ground in the harbor, both having been dredged to a depth of 8 feet at mean low water. During the year 1884 the channel at the entrance was slightly widened. At the close of the year ended June 30, 1888, $32,500 had been expended.

A new project was submitted in 1887, based upon a survey made in accordance with the requirements of the act of August 5, 1886, for a channel 12 feet deep at mean low water and 150 feet wide from the Choptank River to the Railroad Wharf and for dredging the inner harbor below the draw-bridge to 10 feet, and above the bridge to 8 feet at mean low water, at an estimated cost of $17,736.60.

Under the present project, $4,828.91 were expended during the fiscal year ending June 30, 1889, making a total of $37,328.91 expended on the improvement of the harbor to that date.

No work was done during the fiscal year ending June 30, 1890. At the close of operations in 1889, there existed a channel 12 feet in depth and 88 feet wide across the bar to opposite the Maryland Steamboat Company's Wharf, and 22 feet wide as far as the Railroad Wharf, which enabled vessels drawing 11½ feet of water to sail directly to the latter point without much difficulty.

July 1, 1889, amount available.....	$171.09
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889.....	71.09
July 1, 1890, balance available.....	100.00
Amount appropriated by act of September 19, 1890.....	5,000.00
Amount available for fiscal year ending June 30, 1891	5,100.00
Amount (estimated) required for completion of existing project..... Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	7,736.60

(See Appendix H 14.)

15. *Removing sunken vessels or craft obstructing or endangering navigation.*—During the past fiscal year the following wrecks were removed under the provisions of the act of June 14, 1880: The pungy *Eva Hemingway* from Choptank River, Maryland, the schooner *Two Brothers* from the harbor at Cambridge, Md., and the schooner *Jesse W. Knght* from Chesapeake Bay, near Sharp's Island.

(See Appendix H 15.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENT, TO COMPLY WITH REQUIREMENTS OF RIVER AND HARBOR ACT OF AUGUST 11, 1888.

It appearing from the preliminary examination made by the local engineer that the following localities are worthy of improvement, and the public necessity therefore being apparent from the facts and reasons

reported, which are concurred in by the Chief of Engineers, William F. Smith, United States Agent, Major of Engineers, U. S. Army, Retired, was charged with and completed their survey, the results of which were transmitted to Congress and printed in Ex. Docs. of the Fifty-first Congress, first session.

1. *Appoquinimink Creek, Delaware*—Printed as House Ex. Doc. 19. (See also Appendix H 16.)

2. *Wicomico River, Maryland.*—Printed as House Ex. Doc. 20. (See also Appendix H 17.)

3. *North East River, Maryland.*—Printed as House Ex. Doc. 21. (See also Appendix H 18.)

4. *Chester River, between Crumpton and Jones' Landing, Maryland.*—Printed as House Ex. Doc. 65. (See also Appendix H 19.)

5. *Manokin River, Maryland.*—Printed as House Ex. Doc. 149. (See also Appendix H 20.)

6. *Elk River, Maryland.*—Printed as House Ex. Doc. 157. (See also Appendix H 21.)

7. *Onancock Harbor, Virginia.*—Printed as House Ex. Doc. 83. (See also Appendix H 22.)

8. *Harbor of Cape Charles City and approaches by Cheuton Inlet, Virginia.*—Printed as House Ex. Doc. 29. (See also Appendix H 23.)

9. *Chincoteague Inlet, Virginia.*—Printed as House Ex. Doc. 207. (See also Appendix H 24.)

IMPROVEMENT OF PATAPSCO RIVER AND CHANNEL TO BALTIMORE, MARYLAND, AND OF JAMES RIVER, VIRGINIA.

Officer in charge, Capt. Thomas Turtle, Corps of Engineers, until July 23, 1889, and after that date Col. W. P. Craighill, Corps of Engineers.

1. *Channel to Baltimore, Maryland.*—The depth of this channel has been by successive steps increased from 17 feet at mean low water to 27 feet, with an average rise of tide of about 18 inches.

The project of improvement first adopted and commenced in October, 1853, had for its object to give a channel 22 feet deep at mean low water with a width of 150 feet.

Little was done before the late war, but afterwards these dimensions were increased, a depth of 24 feet at mean low water being determined upon with a width of channel ranging from 250 to 400 feet.

This channel was completed in 1874, important changes of position having been given to a portion of it, by which the distance was materially lessened and the expense of maintenance decreased.

The object of the improvement was to permit the approach to Baltimore, at mean low water, of vessels drawing from 22½ to 23 feet and at ordinary high water of vessels drawing 24 and 24½ feet. Later the project had in view a depth of 27 feet at mean low water with a width of 600 feet, and this was in progress June 30, 1889, with funds granted by the act of August 11, 1888, by which an appropriation of $300,000 was made.

Operations were brought to a close in August, 1889, for want of money and were not resumed in the year ending June 30, 1890. The channel throughout has been excavated to 27 feet at low water. The Craighill Channel below the Cut-off, the Cut-off Channel and the Brewerton above the Cut-off have been excavated to 400 feet width; the Fort McHenry Division is generally 250 feet in width, except at the upper end where it is 500. All the angles are much wider, the object being to facilitate

the movement of large ships at these turns. The portions of the Brewerton below the Cut-off and of the Craighill above it have not been dredged for years, and are not now considered a part of the channel under improvement by the United States. Their width is about 250 feet and the depth 24.

Up to June 30, 1889, the United States had expended $2,359,433.27 with the result indicated above. The city of Baltimore and the State of Maryland, chiefly the former, have also contributed to the same object more than $500,000. The expenditure up to June 30, 1890, by the United States was $2,461,997.65.

July 1, 1889, amount available	$148,193.89
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	102,564.38
July 1, 1890, balance available	45,629.51
Amount appropriated by act of September 19, 1890	340,000.00
Amount available for fiscal year ending June 30, 1891	385,629.51
Amount (estimated) required for completion of existing project	360,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	360,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix I 1.)

2. *James River, Virginia.*—When the improvement of the James River was regularly undertaken by the Government the navigation was obstructed by sunken vessels, by remains of military bridges, and by other obstructions put into the river during the late war to prevent the national fleets from approaching too close to Richmond.

There were also other natural obstructions. Rockett's Reef and Richmond Bar had only 7 feet of water at mean low tide. From Warwick Bar to Richmond the channel was crooked and obstructed by dangerous rocks and ledges, the Dutch-Gap Cut-off was not then open, and the river was in a poor condition as regards its availability for commercial purposes.

The original project of improvement was to secure a depth of 18 feet at full tide (corresponding to about 15 feet at low tide) to Richmond, with a channel width of 180 feet. This project had reached an advanced stage of progress when Congress, by act approved July 5, 1884, adopted the project looking to 22 feet at mean low tide from the sea to Richmond, the width to be 400 feet from the sea to City Point, 300 from thence to Drewry's Bluff, and 200 feet from thence to Richmond.

July 1, 1888, the available balance was $1,047.98. The additional sum of $225,000 was provided by the law of August 11, 1888. No appropriation was made in 1889.

The total amount expended on this river by the United States up to June 30, 1889, was $1,094,539.86 which includes the sum of $363,655.31 expended since the new project has been entered upon to give a depth of 22 feet at mean low water. The condition of the river June 30, 1889, was as follows: the available draught from the sea to City Point at high tide was 19½ feet; thence to Kingsland, 18 feet; over Kingsland, 16 feet; thence to Richmond, 16½ feet.

The amount expended in the year ending June 30, 1890, has been $69,137.48, and the following is the practical available draught at high water: from the sea to Curl's Neck, 19½ feet; thence to Goode's rocks, 18 feet; thence to Richmond, 16½ feet.

The principal operations of the year have been dredging at the cut near Stearn's Dike in the Dutch Gap Cut-off, in the partial removal of

a landslide, and at Kingsland Bar; the building of training-walls opposite the Dutch Gap Cut-off and at Kingsland; the removal of rock at Goode's; and the making of a survey from Dutch Gap to Jordan's Point, 21¼ miles,

Upon representation of the need thereof harbor lines were laid down from the city of Richmond to Drewry's Bluff by a Board of Engineer officers, which were approved by the Secretary of War.

When the proposed improvement is completed an annual expenditure of $20,000 will be necessary for the maintenance of the channel.

July 1, 1889, amount available		$70,723.35
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$69,137.48	
July 1, 1890, outstanding liabilities	800.00	
		69,937.48
July 1, 1890, balance available		785.87
Amount appropriated by act of September 19, 1890		200,000.00
Amount available for fiscal year ending June 30, 1891		200,785.87
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		3,736,070.45

(See Appendix I 2.)

IMPROVEMENT OF THE HARBOR AT NORFOLK, AND ITS APPROACHES, VIRGINIA; APPROACH TO NORFOLK, VIRGINIA; OF NANSEMOND RIVER, VIRGINIA, AND APPOMATTOX RIVER, VIRGINIA; NORTH LANDING RIVER, VIRGINIA AND NORTH CAROLINA; CURRITUCK SOUND; COANJOK BAY, AND NORTH RIVER BAR, NORTH CAROLINA.

Officer in charge, Lieut. G. J. Fiebeger, Corps of Engineers; Division Engineer, Col. William P. Craighill, Corps of Engineers.

1. *Harbor of Norfolk, and its approaches, Virginia.*—The project for improvement adopted in 1877 was to deepen and widen the channel at the mouth of the Southern Branch and along the Berkley and Portsmouth Flats, in the harbor proper, and for the approaches to dredge a channel 500 feet wide and 25 feet deep, at ordinary low water, through the bars at the Western Branch and Sewell's Point.

The revised project of 1885 is as follows: (1) To secure a channel not less than 25 feet deep and 500 feet wide at ordinary low water, by dredging from the deep water of Hampton Roads to Norfolk and the United States Navy-yard on the Southern Branch, and also to secure a channel in the Eastern Branch at the same stage, not less than 22 feet deep, with a width at least 300 feet at the Norfolk and Western Railroad Bridge, and gradually increasing to about 700 feet at its mouth, by dredging between said points; and (2) to ultimately dredge the entire area bounded by lines parallel to and 75 feet from the port-warden lines to a depth not less than 25 feet at ordinary low water, from Fort Norfolk to the United States Navy-yard, and not less than 22 feet from the mouth of the Eastern Branch to Campostella Bridge, and to construct a bulkhead at Berkley Flats.

With slight modification, all operations have been conducted in accordance therewith.

The amount expended to June 30, 1889, was $482,569.91, which resulted in a channel at least 250 feet wide and 25 feet deep from Hampton Roads to Norfolk Harbor; a channel of the same depth and 125 to 500 feet wide in the Southern Branch to the United States Navy-yard,

and a channel 22 feet deep and 200 feet wide in the Eastern Branch to the Norfolk and Western Railroad Bridge.

The channel thus dredged was in a good condition August 1, 1889, except at the mouth of the Eastern Branch, where it was 20 feet.

There was expended in the fiscal year ending June 30, 1890, $426.19, which was applied to office expenses, care of property, and surveys.

The establishment of the harbor lines has increased the ultimate amount of dredging called for in the project of 1885.

July 1, 1889, amount available	$2,430.09
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	426.19
July 1, 1890, balance available	2,003.90
Amount appropriated by act of September 19, 1890	150,000.00
Amount available for fiscal year ending June 30, 1891	152,003.90
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	307,744.00

(See Appendix J 1.)

2. *Approach to Norfolk Harbor and the United States (Norfolk) Navy-yard between Lambert's Point and Fort Norfolk.*—The original condition of this channel was good with the exception of the shoal opposite the mouth of Western Branch, over which there was a navigable depth of 19 feet at ordinary low water.

The project of 1878 was to dredge a channel 500 feet wide and 25 feet deep at ordinary low water the entire length of the shoal, 4,800 feet.

The revised project of 1886 is: (1) To secure a channel not less than 25 feet deep and 500 feet wide at ordinary low water from Lambert's Point to Fort Norfolk by the construction of a dike and by dredging. (2) To ultimately widen this channel to within 75 feet of a straight line drawn from Fort Norfolk to the deep water opposite Lambert's Point, 6,800 feet of which is the proposed port-warden's line, making the channel at least 700 feet wide.

From July 5, 1884, to June 30, 1889, there was expended on this improvement $162,474.74, which resulted in a channel 700 feet wide and 25 feet deep at ordinary low water, and a channel of the same depth and 600 feet wide from the deep water off Lambert's Point to the port-warden line.

During the year ending June 30, 1890, there was expended on this improvement $4,709.60, including outstanding liabilities, which was applied to office expenses, surveys, care of property, and final payment on contract.

The project of 1885 has been completed with the exception of the dike. The survey of 1889, and examinations made during the month of April, 1890, indicate that the dike will not be necessary to the maintenance of the channel. No further appropriation will therefore be required for this improvement.

July 1, 1889, amount available		$9,509.39
Amount received from officer for sale of fuel		10.50
		9,519.89
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$4,607.16	
July 1, 1890, outstanding liabilities	102.44	
		4,709.60
July 1, 1890, balance available		4,810.29

Amount (estimated) required for completion of existing project..... Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	$108,000.00

(See Appendix J 2.)

3. *Nansemond River, Virginia.*—In 1872 the navigable channel of the Nansemond River from Suffolk to Hampton Roads was 5 feet deep at ordinary low-water over the shoals, and was much obstructed by wrecks, piles, snags, etc.

From 1873 to 1878, inclusive, the expenditures made by the United States for the above improvement amounted to $37,000. The result was a navigable channel 8 feet deep, which is still unimpaired. No work was done between 1880 and 1889.

In obedience to the requirements of the river and harbor act of August 5, 1886, a preliminary examination and survey were made of the river, a report of which is found in Appendix L 13 of the Report of the Chief of Engineers for 1887.

The plan of improvement proposed provides for a channel not less than 100 feet wide at bottom, 12 feet deep at mean low water, from the head of navigation to the mouth of Western Branch, 5.37 miles, including a turning-basin 200 feet square 300 feet below Suffolk Bridge, by dredging and the construction of spurs and training-walls; and a channel of like depth from mouth of Western Branch to deep water at Town Point, 200 feet wide at bottom at its upper end and gradually increasing to at least 400 feet at its lower end, etc.; the total estimated cost being in round numbers, $152,500.

The amount expended up to close of fiscal year ending June 30, 1889, is $219.63. During the fiscal year there has been expended on this work $2,465.88. These amounts were applied to repairing dike at the mouth of the Western Branch and to dredging a shoal near Suffolk. The dredging resulted in a channel 40 feet wide and 11 feet deep at ordinary low water, where the depth was formerly 7 to 8 feet.

July 1, 1889, amount available.....	$3,891.37
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889.....	2,465.88
July 1, 1890, balance available.....	1,425.49
Amount appropriated by act of September 19, 1890.....	10,000.00
Amount available for fiscal year ending June 30, 1891.....	11,425.49
Amount (estimated) required for completion of existing project..... Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	132,500.00

(See Appendix J 3.)

4. *Appomattox River, Virginia.*—At the close of the late war the navigation of this river was in such a condition that the depth of water on more than one of the shoals did not exceed 6½ feet at high tide, and this depth was diminished by 3 feet at low tide. The plan of the improvement adopted in 1870 was to attain a depth of 12 feet at high tide, with as much width of channel as the river would bear. This plan has been steadily adhered to, constant progress being made towards its completion from year to year by the use of the money granted by Congress. The means depended on have been revetments, jetties, dams, and training-walls, with resort to the dredge only when the needs of commerce required immediate work in the channel to give more width or depth than had been attained under the slower operations of the structures mentioned, of which the system has not yet been fully carried out for

want of sufficient funds. Puddledock Cut, 2 miles long, has been enlarged, and the river was diverted from old channel into it.

The amount expended by the United States up to June 30, 1889, on the project adopted in 1870, $388,617.23, resulted in securing a channel whose ordinary depth at high water varies from 10 to 12 feet.

During the fiscal year there has been expended $4,692.64, including outstanding liabilities, on this improvement. This was applied to the relief of commerce by dredging shoals formed by the annual freshets, care, and repair of plant, etc.

The navigable depth of the river is now 10½ feet except at Puddledock Cut Shoal, where the depth at ordinary high water is 9½ feet for a distance of 400 feet.

All work within the city limits has been done by the city of Petersburg, which keeps a dredge for this purpose.

An annual appropriation of about $12,000 will be required to protect the works already constructed and keep open a channel from 10 to 12 feet deep from the docks at Petersburg to the mouth of the river.

July 1, 1889, amount available		$5,132.77
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$4,679.69	
July 1, 1890, outstanding liabilities	12.95	
		4,692.64
July 1, 1890, balance available		440.13
Amount appropriated by act of September 19, 1890		15,000.00
Amount available for fiscal year ending June 30, 1891		15,440.13
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		15,080.00

(See Appendix J 4.)

5. *North Landing River, Virginia and North Carolina.*—Originally this river was much obstructed by logs, snags, overhanging growth, etc., and also by shoals and abrupt bends, the least depth being 6½ feet in places.

The original project, adopted in 1879, is to make a channel at low water not less than 9 feet deep and 80 feet wide its entire length—17 miles—by dredging the shoals and bends and by removing the obstructions.

The amount expended to June 30, 1884, was $49,777.34, and resulted in completing the project; thereby allowing much larger vessels to pass over the river and increasing its commerce.

From 1884 to 1889 the total amount expended on the river was $2,092.97, which was applied to the removal of sunken logs and other obstructions.

There was expended for the same purpose during the fiscal year, $964.38; the river was again free from obstructions from North Landing Bridge to Ferraby's Island.

The entire river was examined during the year, and, after the obstructions were removed, found to be in a good condition. Future operations will be confined to the removal of occasional shoals and the logs abandoned by passing rafts.

July 1, 1889, amount available	$3,629.69
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	964.38
July 1, 1890, balance available	1,665.31

(See Appendix J 5.)

6. *Currituck Sound, Coanjok Bay, and North River Bar, North Carolina.*—Previous to the commencement of this improvement there was an indifferent natural channel with a depth of from 5 to 7 feet at low water, which had been partially dredged, in the sound and bay, by the Albemarle and Chesapeake Canal Company.

The original project, adopted in 1878, is to obtain a channel 80 feet wide at bottom and 9 feet deep at ordinary winter water, by dredging the entire length of the sound, 10½ miles, to which was added, in 1880, the project to prolong this channel by dredging through the bay about 2 miles, and to construct a shell dike 9,600 feet along the westerly side of the channel through the latter, to maintain it. In 1885 it was further enlarged by the project to dredge a straight channel through North River Bar, 7,150 feet long, 150 feet wide, and 9.4 feet deep at ordinary low water.

The amount expended to June 30, 1889, is $135,004.96, and resulted in the construction of the dike and a channel in the sound and bay and across the bar from 40 to 80 feet wide, the entire length and depth proposed, all of which greatly improved navigation and increased the commerce over this route.

The entire channel was examined in July, 1889. It was found to be somewhat obstructed by sunken logs, but otherwise in a fair condition. It is probable that the maintenance of this channel will require occasional dredging to remove shoals formed by steamers grounding along its sides. No work has been done on North River Bar since 1887.

There was expended on this work during the fiscal year $6,651.20, which was applied to dredging a channel 60 feet wide and 4,250 feet long and 9 feet deep through a shoal near Long Point, Currituck Sound, 21,494 cubic yards of material being removed.

This improvement is on the important inland water-route connecting Chesapeake Bay and Albemarle Sound. The other waters of the United States on this route are the Elizabeth, North Landing, and North rivers; the first two were under improvement until a channel 80 feet wide and 9 feet deep was obtained.

July 1, 1889, amount available	$7,495.04
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	6,651.20
July 1, 1890, balance available	843.84
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	39,885.68

(See Appendix J 6.)

7. *Removing sunken vessels or craft obstructing or endangering navigation.*—During the fiscal year the wreck of the *E. L. Pettengill* was removed under authority of act of Congress approved June 14, 1880.

This wreck was a dangerous obstruction lying in the channel between Cape Henry and Hampton Roads. On August 10, 1889, a contract was entered into with Mr. George McBlair, to remove the wreck for $1,325. The work was completed August 30, 1889.

(See Appendix J 7.)

IMPROVEMENT OF THE POTOMAC RIVER AT WASHINGTON; CONSTRUCTION OF BRIDGE ACROSS THE EASTERN BRANCH OF THE POTOMAC AT WASHINGTON.

Officer in charge, Lieut. Col. Peter C. Hains, Corps of Engineers.

1. *Potomac River at Washington, District of Columbia.*—Before the improvement was commenced the channel to Georgetown was narrow,

crooked, and had not sufficient depth to accommodate commerce. Vessels drawing 16 feet frequently grounded at high water above Long Bridge, and to maintain this depth frequent dredging was necessary, and even then the channel was narrow, as the appropriations for dredging were only sufficient to make a narrow cut through the bar. The Washington Channel was not only shoal, but narrow, and wholly inadequate to the wants of commerce.

The flats in front of the city were large in area, sometimes covered, sometimes not covered, by the water of the river, which was polluted by the sewage of a large city. The sewer at the foot of Seventeenth street discharged its contents on the flats, rendering some parts of the city in that vicinity almost uninhabitable.

By act passed August 2, 1882, Congress adopted a project which had for its object the improvement of the navigation of the river by widening and deepening its channels, the establishment of harbor lines beyond which no obstructions should be built, and at the same time the filling of the flats or marshes on the city front, so that they would not be overflowed by the highest tides, the material dredged from the channels to be used in filling the flats.

The project provides for such depth of channels as will accommodate the largest class of vessels that can reach Arsenal Point with such additional depth at the wharves as will enable vessels to receive full cargoes without grounding at low water; for filling the flats above Long Bridge to a height of 3 feet above the flood-line of 1877, and the middle part of the flats below Long Bridge to the same height, sloping to 6 feet above mean low tide at the margin; that in order to purify the water of the Washington Channel, which will be cut off at the upper end from the Virginia Channel, a tidal reservoir or basin be established between the sewer-canal and Long Bridge, to be filled by water from the Virginia Channel on the flood-tide, and discharged into the Washington Channel on the ebb. The plan also contemplates the rebuilding of Long Bridge with longer spans during the progress of the work, and the intercepting of all sewage now discharged into the Washington Channel, and its conveyance to James Creek, but neither the reconstruction of the bridge nor the building of the intercepting sewer were included in the estimated cost of the improvement.

The amount expended up to the close of the fiscal year ending June 30, 1889, is $1,423,764, or rather more than one-half the estimate for the entire work. At that date a channel 350 to 550 feet wide, and not less than 20 feet deep at low tide, had been dredged between Georgetown and Giesboro Point. That portion of the channel below the Long Bridge had maintained its full width and depth, but the part above the bridge had shoaled to about 14 feet at low tide. The Washington Channel had been dredged to a width of 350 feet, and 20 feet deep, which depth had been somewhat decreased by deposits during the freshet of June 2, 1889. The removal of the shoal at the junction of the Washington and Virginia channels was about completed, materially lessening the distance from Washington Harbor to Georgetown, besides facilitating entrance to the former. All the material taken from the channels had been deposited on the flats, of which about 544 acres had been raised above overflow by ordinary high tides, a part being up to grade. Of the total quantity of material needed to fill the flats to the required height, a little more than one-half had been deposited on them. The construction of the reservoir outlet was well advanced.

The amount expended during the fiscal year ending June 30, 1890, is $137,941.50. This sum has been devoted to dredging in the Washington Channel, raising embankments and protecting the same, and construct-

ing the Reservoir Outlet. The latter is completed with exception of one course of stone and the coping. The channel above Long Bridge, which had filled up to about 14 feet at low tide (or 17 feet at high tide), has been re-dredged to a depth of not less than 18 feet at low tide (or 21 feet at high tide) for a width of about 140 feet. The Washington Channel has been widened on its westerly side for about two-thirds of its length, by dredging to a depth of 12 feet. The increase in width varies from 100 to 250 feet, effecting a decided improvement in the harbor. Almost the entire area to be reclaimed has been raised to a grade above overflow by mean high tides.

The dredging in the Washington Channel is now nearly finished. It is deep, and for the most part wide and commodious. A single freshet is apt to damage it immensely. The amount of material that can be washed into it, scattered over a large space, will necessitate expensive dredging to remove. The embankments around the margin of the fill to retain the material placed on the flats, have now been raised to a considerable height. They are constantly being eroded by the waves and need frequent expenditures to maintain them.

Long Bridge.—The necessity for the reconstruction of Long Bridge is again referred to. It is imperative that this work should not be delayed, if the destruction of the bridge itself, as well as damage to the work on the River Front, and still greater damage to the city, is not to be invited. The Government has expended $1,500,000 in improving the navigation and raising the flats. While Long Bridge remains as it is some of the work on the channel has to be done over and over again. The trouble is not that there is a bridge at this place; it is because of the faulty construction of the bridge. As stated in former reports, the spans are short, the piers too numerous, and set in positions that make them more obstructive to the flow of the water than they need be. Besides, they are built on pile and grillage foundations which reach to about the level of low water, and have enrockments or mounds of stone around them, which still further obstructs the flow of water under the bridge. It is of the utmost importance that the portion of the bridge which spans the main channel of the river be rebuilt without further delay.

July 1, 1889, amount available		$52,303.74
July 1, 1889, amount covered by existing contracts		81,743.39
		134,047.13
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$120,752.63	
July 1, 1890, outstanding liabilities	1,565.58	
July 1, 1890, amount covered by uncompleted contracts made during the fiscal year ending June 30, 1890	6,544.20	
		128,862.41
July 1, 1890, balance available		5,184.72
Amount appropriated by act of September 19, 1890		280,000.00
Amount available for fiscal year ending June 30, 1891		285,184.72
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		861,365.00

(See Appendix K 1.)

2. *Bridge across the Eastern Branch of the Potomac River, District of Columbia.*—This bridge is located at the foot of Pennsylvania avenue southeast, in the District of Columbia. It was authorized by act of Congress approved February 23, 1887, by which an appropriation of $110,000 was made. On September 20, 1887, a contract for the construction of an iron bridge resting on masonry piers was made with

the Groton Bridge and Manufacturing Company, of Groton, N. Y. The total price was $105,000. The original plan provided for a 90-foot through span at the west end of the bridge, over the tracks of the Baltimore and Potomac Railroad Company. When the contractors commenced the excavation for the foundation for the west abutment they were forcibly interfered with by the railroad company, which claimed that the abutment encroached upon the company's right of way. Subsequently the railroad officials expressed a desire to move their tracks about 187 feet to the eastward of their existing location.

By act approved May 14, 1888, Congress authorized the Secretary of War to make such changes in the plan of the bridge as would best accommodate the traffic over and under it, and appropriated $60,000 to provide for the cost, coupling therewith a proviso that the railroad company should pay its fair and just proportion of the cost of the changes at the west end of the bridge. In July, 1888, a supplemental contract was made with the Groton Company for the erection at the west end of the bridge of two through spans of 151 feet each, in place of one 90 foot through span and two 112-foot deck spans, as originally designed. The additional price to be paid the contractors for these alterations was $40,000.

At the close of the year ending June 30, 1889, nine iron deck spans were erected and their piers completed, the embankment for the eastern approach was nearly completed, and the contractors were engaged in the construction of the two 151 foot through spans and the piers to support them. The west abutment was nearly completed.

During the fiscal year ending June 30, 1890, the construction of the bridge under the Groton contract was completed, and the bridge was opened to public travel on March 20, 1890. An unexpended balance of about $14,000 was applied to work on the approaches, etc., which is now completed.

July 1, 1889, amount available		$15,846.76
July 1, 1889, amount covered by existing contracts		80,455.56
		96,302.32
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$88,133.93	
July 1, 1890, outstanding liabilities	7,157.03	
		95,290.96
July 1, 1890, balance available		1,011.36

(See Appendix K 2.)

To comply with a resolution of the Senate of the United States of February 13, 1890, the local engineer, Lieutenant-Colonel Hains, was directed to make a special report on the improvement of *Shenandoah River, West Virginia.* This report was transmitted to Congress and printed as Senate Ex. Doc. 65, Fifty-first Congress, first session.

(See also Appendix K 3.)

IMPROVEMENT OF PATUXENT RIVER AND OF THE HARBORS OF BRETON BAY AND ST. JEROME'S CREEK, MARYLAND—OF THE CHANNEL AT MOUNT VERNON—OF RAPPAHANNOCK RIVER AND YORK RIVER, VIRVINIA—OF TRIBUTARIES OF THE LOWER POTOMAC AND OF CERTAIN RIVERS IN VIRGINIA AND NORTH CAROLINA.

Engineer in charge, Mr. S. T. Abert, United States Agent; Division Engineer, Col. William P. Craighill, Corps of Engineers.

1. *Patuxent River, Maryland, from Benedict to Hill's Landing.*—Two only of the five bars between Benedict and Hill's Landing have been

surveyed. These two are Swann's Point and Bristol bars, respectively, 43 and 46 miles from the mouth of the river. At Swann's Point Bar the least depth within the limits of the proposed channel was found to be 7.2 feet at low water. At Bristol Bar the least depth was 4.7 feet near the "County Wharf." Steam navigation on both bars is impeded at low water.

The improvement consists in dredging a cut 200 feet wide and from 12 to 13 feet deep, which will give when completed a channel of about 100 feet wide and 12 feet deep at low water.

Bids received during the fiscal year ending June 30, 1889, were rejected as excessive. Under the letting of August 28, 1889, the contract was awarded to Thomas P. Morgan at 20 cents per yard. Dredging under this contract at Bristol Bar was completed on January 2, 1890, making a channel 120 feet wide and 12 feet deep. The extreme length is 794 feet.

Up to June 30, 1890, $5,000 have been expended, of which sum $4,744.71 were expended during the year.

July 1, 1889, amount available		$4,744.71
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$4,743.21	
July 1, 1890, outstanding liabilities	1.50	
		4,744.71
Amount appropriated by act of September 19, 1890		6,000.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		69,000.00

(See Appendix L 1.)

2. *Channel at Mount Vernon, Virginia.*—Previous to the commencement of this improvement there was a depth of but 4 feet at low water over the wide flat between the wharf at Mount Vernon and the main channel of Potomac River, a distance of 1,900 feet. The present project, adopted in 1879 and amended in 1888, is to excavate a channel from deep water of the Potomac to the wharf at Mount Vernon, which shall have when completed a width of 200 feet and a depth of from 9 to 10 feet at low water, with a turning basin of 200 feet radius.

The amount expended to June 30, 1890, is $14,500.

The channel has been dredged a distance of 2,300 feet from the wharf to the main channel of the Potomac. It has a width varying from 60 to 100 feet; and the basin has a width of 360 feet.

The depths in the channel and basin within the limits mentioned vary from 9 to 12.8 feet.

A survey under the last appropriation showed that the basin was nearly obliterated, and that the work required to complete the channel would be increased by the deposit.

July 1, 1889, amount available	$528.56
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	528.56
Amount appropriated by act of September 19, 1890	2,500.00

(See Appendix L 2.)

3. *Breton Bay, Leonardtown, Maryland.*—The harbor of Leonardtown, at the upper end of Breton Bay, prior to the commencement of the present improvement had a least depth of 5 feet at low water, which was insufficient for the passage of steamers to and from Leonardtown

Wharf. The bar which was assumed to extend to the 9-foot curve in the bay was about 1 mile in length.

The original project submitted in 1875 provided "for a channel 150 feet wide with enlargement at the turn and turning-ground at the wharf. Depth, 9 feet at low water."

In 1885 it was proposed to widen the cut to 200 feet for a distance of 1½ miles, and to enlarge the basin to a width of 400 feet by 800 feet in length, depth in channel and basin to be not less than 10½ feet. The effect of the increased dimensions would be to preserve the navigable width of the channel.

The amount expended to June 30, 1890, is $32,500.

No dredging was done during the fiscal year for want of funds. The condition on June 30, 1889, was as follows:

The total width at the turn varied from 185 to 280 feet. The depth was about 9 feet at low water.

The dimensions above the turn were the same as in 1888.

July 1, 1889, amount available	$839.98
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	839.98
Amount appropriated by act of September 19, 1890	5,000.00
Amount (estimated) required for completion of existing project. Submited in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	12,000.00

(See Appendix L 3.)

4. *Nomini Creek, Virginia.*—This stream is an important tributary of the Potomac, 82 miles below Washington, draining a large area of productive country.

Navigation was obstructed by a bar of sand and oyster shells at its mouth, over which but 3 feet could be carried at low water, and the dangers and difficulties of passing the bar were further increased by a cross-tide and an exceedingly rapid current.

After passing the bar, 8½ feet can be carried to Nomini Ferry, 3 miles above the mouth.

The project for improvement, adopted in 1873, provided for a channel 100 feet wide and 9 feet deep at low water. In 1879, an increase in width to 150 feet was recommended which was again submitted in 1882 with an estimate. In 1885, a further increase to 200 feet was deemed necessary to meet the increased demands of trade. This amendment included a tributary channel, which would increase the tidal supply of the harbor; and the sinking of mats to obstruct the cross-currents which interfere with navigation and tended to fill a part of the channel with sand.

The appropriations have been barely sufficient to keep the channel navigable, and its narrowness renders it difficult and dangerous at night and during the prevalence of winds from the northeast and northwest.

The amount expended to June 30, 1889, was $36,810.80. At the close of work in 1883, a channel was dredged 100 feet wide and 9 feet deep from the 9-foot curve outside the entrance of the creek to White Oak Point, a distance of 4,400 feet.

No dredging was done from 1883 to 1889. During this interval the cut was reduced in width and depth by deposits of sand at several places, and the channel shoaled to the depth of 7.2 feet above the upper end of the cut.

During the year 1889, a channel was re-opened 94 feet wide through

a sand, shell, and gravel bar lying at the mouth of the creek for a distance of about 1,470 feet. The depths in this cut varied from 8.9 feet to 13.8 feet at mean low water. Operations were suspended during the fiscal year 1890 for want of funds. Up to June 30, 1890, $36,986.61 have been expended.

July 1, 1889, amount available	$689.20
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	175.81
July 1, 1890, balance available	513.39
Amount appropriated by act of September 19, 1890	5,000.00
Amount available for fiscal year ending June 30, 1891	5,513.39
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	30,000.00

(See Appendix L 4.)

5. *Harbor at entrance of St. Jerome's Creek, Maryland.*—The outer bar in the bay has a length of 2,193 feet from the 9-foot curve in the bay to Corsey's Point in the creek. The least depth of water on it before improvement was 2.8 feet. The average depth in the channels to the ponds used by the Fish Commission for hatching oysters was one-half foot. The length of the inner channel to the wharf of the Fish Commission is 3,742 feet.

The project was adopted in 1881, and contemplated dredging a channel 100 feet wide and 9 feet deep at low water through the outer bar at the mouth of the creek, and a channel 40 feet wide and 6 feet deep through the south prong of the creek, the material therefrom to be thrown up in a dike so as to form a pond for the purposes of the U. S. Fish Commission. The channel through the outer bar was made navigable and the ponds were formed.

The preservation of the depth on the outer bar is doubtful. The Fish Commission has abandoned the station. The harbor is situated at the most desirable point south of the Patuxent, for a refuge for oyster boats and small sailing-vessels.

Up to June 30, 1890, $26,500 have been expended.

July 1, 1889, amount available	$864.89
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	864.89
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	26,000.00

(See Appendix L 5.)

6. *Rappahannock River, Virginia.*—Before improvement the principal obstructions to navigation were Fredericksburg Bar, which had a least depth at low water of about 4 feet, and Spottswood Bar, 6 miles below Fredericksburg, which had a depth of 6 feet. Besides these there were five smaller bars, within a distance of 12.6 miles below Fredericksburg, with depths of about 8 feet; the bar at Nanzatico Reach, 33 miles below Fredericksburg, and the bar near Tappahannock, 61 miles below Fredericksburg, each had a minimum depth of about 9 feet.

The original project, adopted in 1871, was modified in 1879. It now provides for a channel 150 feet wide and 10 feet deep at Fredericksburg Bar; channels 100 feet wide and 10 feet deep through the bars between Fredericksburg and Port Royal, 30 miles below; and channels 200 feet

wide and 15 feet deep through the two bars between Port Royal and Tappahannock, where a larger class of vessels must be provided for.

Between March 3, 1871, and June 30, 1879, $90,500 were expended upon the first project. Upon the present project $99,586.06 were expended to June 30, 1889.

At that date, the ruling channel depth for 12.6 miles below Fredericksburg, the distance undergoing improvement, was about 8 feet at low water, and the least width of channel having that depth was nearly 100 feet. Navigation is less difficult below Farley Vale. No work has been done on the lower bars near Nanzatico and Tappahannock.

The amount expended during the fiscal year ending June 30, 1890, is $8,835.24, making the total expenditure on the present project to date $108,421.30.

The expenditures during the fiscal year were mainly for extending the systems of dikes at Fredericksburg Bar and at Spottswood Bar. Most of the work was done at the latter point. These dikes are intended to maintain the depth in the channel after dredging rather than to create the depth.

The channels through the bars have been kept open, notwithstanding the injurious action of many freshets.

The condition is now about the same as on June 30, 1889.

An annual expenditure will be required between Fredericksburg and Farley Vale for removing snags, for repair of dikes and protection of the banks, and for dredging of sand deposited by freshets.

The yearly expenditure for these objects may be estimated at from $5,000 to $7,000.

July 1, 1889, amount available		$2,413.94
July 1, 1889, amount covered by existing contracts		7,000.00
		9,413.94
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$6,886.17	
July 1, 1890, outstanding liabilities	1,949.07	
		8,835.24
July 1, 1890, balance available		578.70
Amount appropriated by act of September 19, 1890		15,000.00
Amount available for fiscal year ending June 30, 1891		15,578.70
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		164,000.00

(See Appendix L 6.)

Rappahannock River, Virginia, at Urbana Creek, a tidal tributary thereof.—Before improvement navigation was obstructed by a bar at the mouth over which but 6 feet could be carried.

The present project, adopted in 1879, provides for a channel through the bar 150 feet wide and 10 feet deep at low water.

The plan was extended in 1883 to include the removal of a bar in the harbor, and in 1888 to provide for the addition of works intended to prevent the dredged channels from filling.

The amount expended to June 30, 1889, was $15,650. The condition was as follows—about the same as in 1888—viz: A channel 120 feet wide and 10 feet deep was excavated through the bar at the mouth

and the bar in the harbor was excavated to a depth of 10 feet and a width of from 80 to 300 feet.

The channel through the bar at the mouth had filled in on one side so that its width was reduced from 120 to 90 feet; the depth remained 10 feet.

During the year ending June 30, 1890, $2,850 were expended, making a total of $18,500 expended to June 30, 1890.

The channel at the spit, which forms the mouth of the creek, was widened during the year to 130 feet, and at the turn just below to 300 feet.

A dike, to arrest the sand, 80 feet in length has been built on the inside of the spit, and another on the outside 160 feet in length. The wattling, to prevent the waves from breaking through the spit, has been repaired for the length of 212 feet.

July 1, 1889, amount available	$2,850.00
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	2,850.00
Amount appropriated by act of September 19, 1890	3,000.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	13,080.00

(See Appendix L 6.)

7. *Totusky River, Virginia.*—The obstructions to navigation in this river consisted of two bars, one at its mouth, which forms a part of the wide flat between the outlet of the river and the navigable channel of the Rappahannock, having a least depth of 4½ feet, and the other, about 2½ miles above the mouth, known as Booker's Bar, having a ruling depth of 3 feet.

Up to August 2, 1882, the date of the last appropriation, $10,000 were appropriated. This sum has been expended in building and repairing a longitudinal dike 2,117 feet in length, the effect of which has been to scour out the channel at Booker's Bar to a depth of 3½ feet at low water.

Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	$12,000

(See Appendix L 7.)

8. *Mattaponi River, Virginia.*—This stream empties into York River, at West Point, Va. It is navigable at low water as far as Walkerton, 40 miles above West Point, for vessels drawing 9 feet. Small steamers can go as far as Aylett's, 12 miles farther, and it can be made navigable for barges to Mundy's Bridge, 26 miles above Aylett's. Before the commencement of the improvement, the river was obstructed by three or four bars, and by snags, wrecks, and overhanging trees.

The original project, based on a reconnaissance in 1875, was adopted in 1880, the object being to provide a channel 40 feet wide and 5½ feet deep at low water, by the removal of snags, drift, wrecks, and overhanging trees, and by dredging through the bars.

In 1884 an examination was made of the changes which had taken place in Robinson's, Latané's, and Line Tree bars; and in 1885, the project was amended to authorize the construction of dikes at Robinson's and Latané's bars, to preserve channels to be dredged with a bottom width of 40 feet and depth of 6 feet.

To June 30, 1889, $14,229.84 were expended in snagging operations, and in removing wrecks, logs, and overhanging trees from Mundy's Bridge to Robinson's Bar (nearly), a distance of about 34 miles, and in the construction of a portion of the dikes proposed at Robinson's Bar.

In 1883 the obstructions referred to were removed from Mundy's Bridge to Aylett's, a distance of about 24 miles. No work has been done on this portion of the river since that date.

In 1888 similar obstructions were removed from Aylett's to Robinson's Bar (nearly), a distance of about 10 miles.

It is reported that snags, trees, and logs obstruct navigation between Mundy's Bridge and Robinson's Bar. Some trees below Indiantown also obstruct navigation.

Four bars between Aylett's and Robinson's, and also 2 bars between Walkerton and West Point, none of which have ever been surveyed for want of funds, are reported to require improvement.

During the year ending June 30, 1890, $2,070.16 have been expended in the construction by hired labor of dikes at Robinson's Bar. The total amount expended to June 30, 1890, is $16,300.

July 1, 1889, amount available		$2,070.16
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$2,067.05	
July 1, 1890, outstanding liabilities	3.11	
		2,070.16
Amount appropriated by act of September 19, 1890		3 000.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		20,000.00

(See Appendix L 8.)

9. *Pamunky River, Virginia.*—The distance from Hanovertown to West Point is 59 miles. The least depth from Hanovertown to New Castle Ferry, 8 miles, is 1½ feet. From New Castle Ferry to Piping Tree, 8 miles, one bar only requires improvement at the present time. This is Spring Bar, 15¼ miles below Hanovertown, with a least depth of 5 feet. Over all the bars as far as White House, about 29 miles above West Point, not less than 9 feet can be carried.

The project, adopted in 1880, was amended in 1885. The amended project provides for a channel 40 feet wide and from 3 to 5 feet deep from Hanovertown to New Castle Ferry, 8 miles, and 100 feet wide and 7 feet deep at low-water at Skidmore's and Spring bars.

The amount expended to June 30, 1889, was $12,142.02. Snags and overhanging trees were removed from Hanovertown to Cameron's Wharf, 16¼ miles, parts of seven wrecks were removed, and 911½ feet of dike were constructed at Skidmore's and Spring bars.

During the fiscal year ending June 30, 1890, $2,848.81 were expended in removing dangerous snags, logs, and sunken and overhanging trees from New Castle Ferry to Garlick's Ferry, 15 miles; in repairing the dike at Skidmore's Bar; and in replacing two mats at Spring Bar. Five hundred and sixty-six and one-half linear feet of pile and brush dike were built at Skidmore's Bar. All of this work was done by hired labor.

At Skidmore's Bar, 8,076 cubic yards of material were removed by contract. The channel at Skidmore's Bar was dredged 6 feet deep at low water 95 feet wide and about 800 feet long. The center cut was made 7 feet deep and 35 feet wide.

The total expended to June 30, 1890, is $15,490.83.

July 1, 1889, amount available		$2,857.98
February 18, 1890, *cash deposited with Treasurer United States		4.46
		2,862.44
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$2,846.08	
July 1, 1890, outstanding liabilities	7.19	
		2,853.27
July 1, 1890, balance available		9.17
Amount appropriated by act of September 19, 1890		3,000.00
Amount available for fiscal year ending June 30, 1891		3,009.17
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		10,000.00

(* See Appendix L 9.)

10. *York River, Virginia.*—The Pamunky and Mattaponi rivers unite at West Point to form York River, which flows in a southeasterly course for 41 miles and empties into Chesapeake Bay. Its average width as far as Yorktown, a distance of 26 miles, is 1½ miles.

Prior to the commencement of the present improvement navigation was obstructed by two bars; one at West Point 2.1 miles in length, with a ruling depth of 15½ feet at low water; the other at Potopotank Creek, 8½ miles below, with a ruling depth of 18½ feet at low water. With the exception of these two bars the depth of the channel was not less than 20 feet.

The original project for the improvement of the river was adopted in 1880, the object being to provide a channel 22 feet deep at low water. and 100 feet wide through both bars and also a basin of the same depth opposite the wharves at West Point and connecting with the channel. Since the commencement of the work in 1880 the trade at West Point has largely increased, and the depth of 22 feet at low water in the channel does not answer the present demands of navigation. Steamers now load at West Point drawing 24 feet.

The amount expended to June 30, 1889, was $126,310.95, which provided:

(1) A channel through West Point Bar for a distance of about 11,450 feet, with a width varying from 161 feet to 257 feet, and a depth, exclusive of the center cut, of not less than 22 feet at mean low water.

In January, 1890, the ruling depth in the channel, exclusive of the center cut, was 19 feet at low water.

Under the modification of the project, January 4, 1889, a cut 40 feet wide in the centre of the channel was dredged a distance of about 12,120 feet through the bar, to admit the passage at low water of vessels drawing 24 feet. The ruling depth in this cut in January, 1890, was 20.6 feet.

(2) A channel through Potopotank Bar 105 feet wide and 22 feet deep at low water. In January, 1890, the depth varied from 20.8 feet to 21.7 feet at mean low water.

The only dredging at this bar was done in 1881.

These channels have not a width and depth sufficient to accommodate the present trade of York River, which consists of freight brought by rail to West Point to be shipped to foreign and domestic ports.

The dredging under the appropriation of August 11, 1888, was completed in February, 1889.

Observation during previous years, and also examination in 1890,

indicate that silting will reduce the depth on the bar at West Point to 15½ feet, unless the deposits are removed by dredging or prevented by the construction of longitudinal dikes.

Silting occurs much less rapidly at Potopotank Bar.

The total amount expended to June 30, 1890, is $127,489.27.

July 1, 1889, amount available		$2,439.05
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$1,138.32	
July 1, 1890, outstanding liabilities	40.00	
		1,178.32
July 1, 1890, balance available		1,260.73
Amount appropriated by act of September 19, 1890		30,000.00
Amount available for fiscal year ending June 30, 1891		31,260.73
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		97,250.00

(See Appendix L 10.)

11. *Chickahominy River, Virginia.*—Before improvement, the obstructions below Windsor Shades consisted of three bars near that point, upon which the depth was from 4 to 5 feet at low water, and a bar at the mouth of the river upon which the depth at low water was from 11 to 12 feet. The project, as amended in 1882, provides for dredging channels from 100 to 150 feet wide through Windsor Shades, Old Fort, and Binn's bars to a depth of not less than 8 feet at low water, and for dredging a channel through the bar at the mouth with a width of 200 feet and a depth of from 14 to 15 feet at low water.

Up to June 30, 1889, $20,927.12 had been expended. Channels of the required width and depth were dredged through the bar at the mouth and at Windsor Shades, and also through the upper and lower portions of Old Fort and Binn's bars.

The channel at Windsor Shades had been reduced in width on June 30, 1888, to about 75 feet by filling at the sides, and the channel at Binn's Bar had narrowed to about 160 feet. The depths remained as dredged except at Old Fort, which has filled to some extent.

During the year ending June 30, 1890, $572.88 were expended, making a total to that date of $21,500.

During the fiscal year ending June 30, 1890, the channel at Lower Old Fort Bar, sometimes called Osborne's Bar, was completed, as far as the funds would permit, to a depth of 9 feet. The channel was 60 feet wide for a length of 350 feet, and 30 feet wide for a farther length of 450 feet.

Only 105 feet of the length and 30 feet in width were dredged in 1890 to complete the contract.

July 1, 1889, amount available	$477.82
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	477.82
Amount appropriated by act of September 19, 1890	2,500.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	5,000.00

(See Appendix L 11.)

12. *Staunton River, Virginia.* (*a*) *Between Brook Neal and Randolph.*—Before improvement the river could be navigated only by bateaux drawing 1 foot of water. Numerous rock ledges, sand-bars, and rapids occurred between reaches of deeper water well adapted to navigation.

The project for improvement between Brook Neal and Randolph Station, 31 miles below, on the Richmond and Danville Railroad, was adopted in 1879, the object being to secure a navigable channel not less than 35 feet wide and 2 feet deep at low water through the various obstructions.

The amount expended upon this portion of the river to June 30, 1890, is $37,314.53. This expenditure has resulted in making about 29½ miles of the river navigable by small steamers.

The channel at White Rock Falls is now passable by steamers, but the number of dams designed has not yet been completed.

July 1, 1889, amount available		$2,465.82
Febuary 18, 1890,* cash deposited with Treasurer United States		21.02
		2,486.84
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$2,280.35	
July 1, 1890, outstanding liabilities	21.02	
		2,301.37
July 1, 1890, balance available		185.47
Amount appropriated by act of September 19, 1890		8,000.00
Amount available for fiscal year ending June 30, 1891		8,185.47
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		23,200.00

(*See Appendix L 12.)

(*b*) *Between Pig River and Brook Neal.*—The project was adopted in 1882, the object being to secure a channel for bateaux not less than 14 feet wide and from 1½ to 2 feet deep at low water, with a slope of water surface at rapids not greater than 10 feet per mile.

The amount expended to June 30, 1889, was $7,000. This expenditure opened a channel from the Virginia Midland Railroad Bridge to a distance of 18½ miles above. No work has ever been done on the river between the Virginia Midland Crossing and Brook Neal, a distance of about 28½ miles.

No work done during fiscal year ending June 30, 1890, for lack of funds.

February 18, 1890,* cash deposited with Treasurer United States	$13.72
July 1, 1890, outstanding liabilities	13.72

(*See Appendix L 12.)

13. *Dan River, Virginia and North Carolina.*—Before improvement, navigation between Madison, N. C., and Danville, Va., was obstructed by numerous bowlders, rock ledges, sand and gravel bars, and rapids. Between these obstructions were pools or reaches of navigable water.

The original project, adopted in 1880, provided for a channel not less than 35 feet wide, and not less than 1½ feet deep in pools and 2 feet deep in the rapids at extreme low water, from the head of the canal at Danville, Va., to Madison, N. C., a distance of 49.13 miles. It was believed that these depths would give for six months of the year a channel not less than 3 feet in depth through the various obstructions.

The project was afterwards modified to a channel of not less than 16 feet wide and 2 feet deep in the rapids at extreme low water, which were the dimensions excavated.

The amount expended to June 30, 1889, was $50,500, the total appropriated.

This expenditure secured a channel of nearly the dimensions required from Danville to Madison, the proposed head of navigation. Further work is necessary for its completion.

The channel was available for rafting lumber and for bateau-navigation, except at extreme low water, though the current was rapid at several shoals, which it was intended to remedy by the construction of spur-dams.

No work was done during the fiscal year ending June 30, 1890, for lack of funds.

February 19, 1890,* cash deposited with Treasurer United States	$39.63
July 1, 1890, outstanding liabilities	39.63
Amount (estimated) required for completion of existing project Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	7,000.00

(*See Appendix L 13.)

14. *Removing sunken vessels or craft obstructing or endangering navigation*—(1). The removal by contract of the wrecked barge *Amicus*, sunk at Skidmore's Bar, Pamunky River, Virginia, was completed on October 23, 1889.

(2) The canal-boat *W. M. B. Adamson*, sunk off the mouth of Cockle's Creek, in Great Wicomico River, Virginia, was removed by contract, completed May 5, 1890. The wreck and contents, about 5 tons of coal, were sold at public auction on May 14, 1890, for $66.

(See Appendix L 14.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENT TO COMPLY WITH REQUIREMENTS OF RIVER AND HARBOR ACT OF AUGUST 11, 1888.

It appearing from the preliminary examination made by the local engineer that the following localities are worthy of improvement, and the public necessity therefor being apparent from the facts and reasons reported, which are concurred in by the Chief of Engineers, Mr. S. T. Abert, United States Agent, was charged with and completed their survey, the results of which were transmitted to Congress and printed in Ex. Doc's. of the Fifty-first Congress, first session.

1. *Chickahominy Creek (River), Virginia.*—Printed as House Ex. Doc. 41. (See also Appendix L 15).

2. *Occoquan Creek, Virginia.*—Printed as House Ex. Doc. 75. (See also Appendix L 16.)

3. *Aquia Creek, Virginia.*—Printed as House Ex. Doc. 135. (See also Appendix L 17.)

IMPROVEMENT OF CERTAIN RIVERS AND HARBORS OF NORTH CAROLINA AND SOUTH CAROLINA.

Officer in charge, Capt. W. H. Bixby, Corps of Engineers, having under his immediate orders, since October 9, 1889, First Lieut. Mason M. Patrick, Corps of Engineers; Division Engineer, Col. Wm. P. Craighill, Corps of Engineers.

1. *Roanoke River, North Carolina and Virginia.*—When placed under governmental improvement in 1872 this stream possessed a 10-foot depth of channel from its mouth, 62 miles up to Hamilton; thence a 5-foot depth, 67 miles further, to Weldon (about eight months per year), this channel depth being reduced during the low-water season to 10 feet to Hamilton and 2 feet to Weldon. Over the whole 129 miles the river

was more or less obstructed by snags, fallen trees, rocky bars, and by war obstructions.

The original projects of 1872, as so far approved, contemplated the removal of the war blockades, a few rocky bars, and all sunken logs, snags, floating and other obstructions, and the contraction of the channel-way by jetties so as to assure, during the entire year, an unobstructed 10-foot navigation up to Hamilton, and 5-foot navigation up to Weldon. The total final cost of this work below Weldon was estimated in 1872 at $269,000 for a steam-boat channel of 5 feet depth at low water.

Up to June 30, 1889, a total of $81,456.81 had been spent upon this improvement, giving a moderately well-cleared channel over the entire length of the river, allowing a 10-foot navigation to Hamilton and a 2-foot navigation further to Weldon all the year; and also a fairly well-cleared 5-foot navigation all the way to Weldon during eight months of the year.

During the fiscal year ending June 30, 1890, an additional $20,578.01, including outstanding liabilities, was spent upon this improvement.

A channel 184 feet wide and 5 feet deep at dead low water was dredged through Little Rocky Bar, and a channel of the same dimensions is nearly completed through Big Rocky Bar; the worst leaning trees and other obstructions have been removed from the banks and the most dangerous rocks, snags, logs, etc., from the channel.

At Shad Island Bend a survey has been made and some work done preparatory to making a cut-off at this point.

After the improvement is finished, its proper maintenance may cost from $2,000 to $6,000 per year.

July 1, 1889, amount available		$31,543.19
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$19,006.97	
July 1, 1890, outstanding liabilities	1,571.04	
		20,578.01
July 1, 1890, balance available		10,965.18
Amount appropriated by act of September 19, 1890		25,000.00
Amount available for fiscal year ending June 30, 1891		35,965.18
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		131,000.00

(See Appendix M 1.)

2. *Pamlico and Tar Rivers, North Carolina.*—The Pamlico and Tar Rivers are different portions of a single stream, the upper portion being called the Tar.

When placed under improvement in 1876, the Pamlico River had an available depth of only 3 feet at low water in its upper portion, near Washington. The Tar River had, during eight months of the year, an available depth of from 2 to 3 feet for 49 miles up to Tarborough, its practical limit of navigation. The channel of the combined stream was almost completely obstructed by two war blockades, and by floating and sunken stumps and logs, and by overhanging trees.

The original project of 1876 (for the Pamlico) and of 1879 (for the Tar), as since slightly modified and continued to date, proposed to secure a clear channel 9 feet deep at low water up to Washington; thence a channel 60 feet wide and 3 feet deep at low water, 23 miles further, to Greenville, and thence a channel 60 feet wide and 20 inches deep, 60 miles further, to Tarborough and Rocky Mount Little Falls. The final total cost of this work was estimated in 1889 at $92,200.

Up to June 30, 1889, a total of $64,608.53 had been spent upon this improvement in securing a good channel at least 9 feet deep at low water and at least 108 feet wide from Pamlico Sound, 37 miles, up to Washington; thence a fair channel 60 feet wide and 3 feet deep all the year, 23 miles, to Greenville, and thence a similar channel for eight months of the year, 26 miles, to Tarborough.

During the fiscal year ending June 30, 1890, an additional $1,619.37, including outstanding liabilities, was spent on this improvement in minor field work, and in surveys to be used in locating future work.

After the improvement is finished its proper maintenance may cost from $1,000 to $3,000 per year.

July 1, 1889, amount available		$3,391.47
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$1,517.92	
July 1, 1890, outstanding liabilities	101.45	
		1,619.37
July 1, 1890, balance available		1,772.10
Amount appropriated by act of September 19, 1890		10,000.00
Amount available for fiscal year ending June 30, 1891		11,772.10
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		14,200.00

(See Appendix M 2.)

3. *Contentnia Creek, North Carolina.*—When placed under improvement in 1881 this stream had a depth of about 3 feet, during nine months of the year, from its mouth in the Neuse upwards about 63 miles to Stantonsburgh, its practical limit of navigation; but its channel was completely blocked at all stages of water by sunken logs and stumps, and by floating obstructions.

The original project of 1881, as continued to date, proposed to secure a safe and unobstructed 3-foot navigation over this distance during the high-water season of about nine months. The final total cost of this work was estimated in 1888 at $77,500.

Up to June 30, 1889, a total of $43,378.02 had been spent in securing a moderately well-cleared 3-foot navigation over the 31 miles from its mouth up to Snow Hill, and a roughly-cleared 3-foot navigation over 32 miles further to Stantonsburgh, during the high-water season.

During the fiscal year ending June 30, 1890, an additional $550.50, including outstanding liabilities, was spent upon this improvement for minor field work, surveys, and office work.

After the improvement is finished its proper maintenance may cost from $1,000 to $3,000 per year.

July 1, 1889, amount available		$1,621.98
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$497.00	
July 1, 1890, outstanding liabilities	53.50	
		550.50
July 1, 1890, balance available		1,071.48
Amount appropriated by act of September 19, 1890		7,000.00
Amount available for fiscal year ending June 30, 1891		8,071.48
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		25,500.00

(See Appendix M 3.)

4. *Trent River, North Carolina.*—When placed under improvement in 1879 this river had a 6-foot to 8-foot roughly cleared navigation from its mouth at New Berne, up 21 miles to Pollocksville, and a light-draught navigation 9 miles further to Quaker Bridge. Above Pollocksville the bars, snags, and trees prevented all navigation, except occasionally by small flat-boats during high freshets.

The original projects of 1879 to 1889, as continued to date, assumed that 6 to 8 feet of water could be carried at all stages from its mouth 21 miles to Pollocksville, and proposed to secure a thoroughly cleared 3-foot navigation, with at least 50 feet channel width at all stages of water from Pollocksville, 22 miles up, to Trenton, and at least 30 feet channel width and over 3 feet depth during winter stages of water from Trenton, 30 miles up, to the Narrows above Free Bridge, and a good channel for pole-boats 13 miles further to Upper Quaker Bridge.

Up to June 30, 1889, a total of $49,572.38 had been spent in all upon this improvement in securing a well-cleared channel 10 to 12 feet deep at all stages (12 to 14 feet at ordinary stages) from New Berne, 18 miles up, to Pollocksville; thence a well-cleared channel 6 to 8 feet deep at all stages (8 to 9 feet deep at ordinary stages) 7 miles further to Quaker Bridge; thence a well-cleared channel 50 feet wide and 3 feet deep at all stages 15 miles further to Trenton, and a good turning basin at Trenton. In consequence of this improvement, steamboat navigation has been permanently established over the entire river to Trenton.

During the fiscal year ending June 30, 1890, an additional $807.03, including outstanding liabilities, was spent on this improvement for minor field work, surveys, and office work.

After the improvement is finished its proper maintenance may cost from $1,000 to $2,000 per year.

July 1, 1889, amount available		$927.52
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$752.50	
July 1, 1890, outstanding liabilities	54.53	
		807.03
July 1, 1890, balance available		120.59
Amount appropriated by act of September 19, 1890		5,000.00
Amount available for fiscal year ending June 30, 1891		5,120.59
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		16,500.00

(See Appendix M 4.)

5. *Neuse River, North Carolina.*—When placed under improvement in 1878, this river had during nine months of the year a 9-foot depth of channel from its mouth 40 miles up to New Berne, thence a 4-foot depth 50 miles further to Kinston, thence a 3-foot depth 45 miles further to Goldsborough, and thence a 2-foot depth 55 miles further to Smithfield, this channel-depth being reduced during the low-water season to 8 feet at New Berne, 2 feet at Kinston, and 1 foot at Smithfield. Over the whole 190 miles the river was so blocked by war and other obstructions that navigation was impracticable.

The original projects of 1871 for below Goldsborough, and of 1879 for above Goldsborough, contemplated the removal of the war blockades and natural obstructions and the excavation of a few cut-offs, so as to get 4.5 feet at low water all the year to Goldsborough, and 3 feet during nine months to Smithfield. The projects of 1878, 1880, and 1883, as continued to date, propose to remove all sunken logs, snags, floating and other obstructions, and to contract the channel-way by

jetties, so as to assure during the entire year an unobstructed 8-foot navigation 40 miles up to New Berne, and a similar 4-foot navigation 50 miles further to Kinston, and during nine months of the year a 3-foot navigation 100 miles further to Smithfield. The final total cost of this work was estimated in 1888 at $374,000.

Up to June 30, 1889, a total of $233,267.77 had been spent in all upon this improvement, giving a moderately well-cleared channel over the entire length of the river, allowing an 8-foot navigation to New Berne, and a 3-foot navigation to Kinston all the year; also a fair 3-foot navigation to Goldsborough during nine months per year, and to Smithfield six months per year.

During the fiscal year ending June 30, 1890, an additional $12,230.66, including outstanding liabilities, was spent in contracting by jetties a portion of the river below Kinston; in removing the worst obstructions from the banks and from the channel over the 95 miles of the river below the railroad bridge at Goldsborough, and in making a cut across a projecting point at Spicer's Lane Landing preparatory to the future removal of this point.

After the improvement is finished its proper maintenance may cost from $2,000 to $6,000 per year.

July 1, 1889, amount available		$14,232.23
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$10,155.42	
July 1, 1890, outstanding liabilities	2,075.24	
		12,230.66
July 1, 1890, balance available		2,001.57
Amount appropriated by act of September 19, 1890		20,000.00
Amount available for fiscal year ending June 30, 1891		22,001.57
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		106,500.00

(See Appendix M 5.)

6. *Inland water-way between New Berne and Beaufort, North Carolina.*—The inland line of navigation from New Berne to Beaufort Harbor, *via* Clubfoot, Harlowe, and Newport rivers, was established by the State of North Carolina about 1826, and was used thereafter by small craft until about 1856, when its locks broke down and the route was abandoned. This line, about 42 miles in total length, extends from New Berne about 23 miles down the Neuse River, 6 miles up Clubfoot River, 3.21 miles through the Clubfoot and Harlowe Canal, 3.5 miles down Harlowe River, and 6 miles through Newport River to Beaufort Harbor. About 1880 the line was re-opened by the New Berne and Beaufort Canal Company.

When placed under improvement in 1885 this route allowed the passage of small boats of 15 feet width and 3 feet draught, but the commerce was practically nothing.

The original project of 1883 reported this route as worthy of improvement, providing that Congress desired to extend the already existing lines of navigation from the Chesapeake southward, and estimated the cost of a channel 80 feet wide and 9 feet deep at $883,580, increased by the cost of a tide-lock and the canal company's franchise.

A modified project of 1884 for the expenditure of the funds then available, as continued to date, proposed to widen and deepen Harlowe Creek so as to secure a through channel of 5 feet depth at mean low water and of 30 feet bottom width from the mouth of Harlowe Creek

upwards 3.25 miles to its head, and to use the remaining funds upon similar works upon Clubfoot River. The total final cost of this latter project (including also the continuation of the same work through the canal) was estimated in 1886 at $92,000.

Up to June 30, 1889, a total of $24,242.45 had been spent in all upon this improvement, on necessary surveys, in removing the worst logs and stumps from the existing channel, in dredging an excellent channel 13,000 feet long, 30 feet wide, and 5 feet deep at low water through the worst portions of Harlowe Creek, thus securing a far better navigation through this creek than exists through the New Berne and Beaufort Canal, to which it leads.

During the fiscal year ending June 30, 1890, an additional $2,360.67, including outstanding liabilities, was spent in additional dredging near the mouth of Harlowe Creek, in repairs of sheet piling, in office duties and minor work.

Further work is postponed to await action on the part of the owners of the canal as to its cession or sale.

After the proposed channel is opened its proper maintenance may cost from $1,000 to $3,000 per year.

July 1, 1889, amount available		$10,757.55
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$2,355.67	
July 1, 1890, outstanding liabilities	5.00	
		2,360.67
July 1, 1890, balance available		8,396.88
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		57,000.00

(See Appendix M 6.)

7. *Harbor at Beaufort, North Carolina.*—This harbor, at the eastern terminus of the Atlantic and North Carolina Railroad, is the only harbor of any importance between Chesapeake Bay and Wilmington, N. C., a distance of over 300 miles.

When placed under improvement, in 1880, it possessed a bar entrance of 15.3 feet least depth at mean low water, with an average rise and fall of tide of 3 feet. At this time, however, the northern entrance was rapidly deteriorating; its width, measured from Fort Macon Point to Shackleford Point, having increased 500 feet between the years 1864 and 1880, and 900 feet more between the years 1880 and 1881, and its bar having rapidly and proportionally shoaled. From the bar, the harbor possessed a channel of 25 feet depth upwards for 3.7 miles to the Atlantic and North Carolina Railroad Wharf at Morehead City, and a branch channel of 9 feet depth for six-tenths of a mile up to Bulkhead Channel, and of 2 feet minimum depth for six-tenths of a mile further to the wharves of Beaufort City, where coasting vessels had a good wharfage of 7 feet depth and 1,800 feet length.

The projects of 1881, 1882, and 1884, as continued to date, proposed to secure this harbor by stopping further erosion of the sand-banks at Shackleford Point and Fort Macon Point, and thus stopping further deterioration of the bar entrance, and proposed to open a 5-foot channel 100 feet wide to Beaufort City. The total final cost of this work was estimated in 1887 at $163,000.

Up to June 30, 1889, a total of $101,972.62 had been spent in all upon this improvement in successfully stopping the erosion of Shackleford Point and Fort Macon Point, in arresting the shoaling on this bar, in building catch-sand-fences at Shackleford Point, in cutting a narrow

channel through the shoal in front of Beaufort City, and in making a careful survey of the present condition of the harbor entrance preparatory to the definite location of future work.

During the fiscal year ending June 30, 1890, an additional $20,061.81, including outstanding liabilities, was spent in strengthening existing jetties, in building and raising catch-sand-fences and shore revetments at Shackleford Point and Fort Macon Point, in completing the cut across the Beaufort City Shoal (leaving the channel everywhere from 25 to 50 feet wide and 5 feet deep at low water), in office and minor field work.

This improvement, once thoroughly finished, should be comparatively permanent.

July 1, 1889, amount available		$23,027.38
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$19,887.34	
July 1, 1890, outstanding liabilities	174.47	
		20,061.81
July 1, 1890, balance available		2,965.57
Amount appropriated by act of September 19, 1890		15,000.00
Amount available for fiscal year ending June 30, 1891		17,965.57
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		23,000.00

(See Appendix M 7.)

8. *Inland water-way between Beaufort Harbor and New River, North Carolina.*—When placed under improvement, in 1886, there was a channel 18 inches deep at low water from Beaufort to the town of Swansborough, on White Oak River; thence a 3-foot depth at mid-tide, 6 miles further to Bear Inlet and Creek; thence a 6-inch depth at low water, 11 miles further to New River, whence boats of 5 feet draught could proceed 21 miles further to the town of Jacksonville.

The original project of 1885, as continued to date, recommended the establishment of a channel of at least 3 feet depth at low water from Beaufort to Swansborough. The total final cost of this work was estimated in 1887 at $50,000.

Up to June 30, 1889, a total of $14,595.06 had been spent in all upon this improvement in securing a channel-way of at least 40 feet width and of 3 feet depth at high water from Beaufort to Swansborough.

During the fiscal year ending June 30, 1890, an additional $42.83, including outstanding liabilities, was spent in office duties and minor work, no field work being advantageously possible with the small amount of funds available.

Government property was stored and cared for at Beaufort, N. C.

This improvement, once thoroughly finished, should be comparatively permanent.

July 1, 1889, amount available	$404.94
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	42.83
July 1, 1890, balance available	362.11
Amount appropriated by act of September 19, 1890	15,000.00
Amount available for fiscal year ending June 30, 1891	15,362.11
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	20,000.00

(See Appendix M 8.)

9. *New River, North Carolina.*—When placed under improvement in 1882 this river had very poor facilities for transporting goods to market. Its outlet to the ocean was blocked by an oyster-rock barricade, through which there existed only a long and very crooked channel of 50 feet width and 3 feet depth at low water.

The original project, as continued to date, proposed to secure a 150-foot channel 5 feet deep at low water from the upper river to the ocean by dredging. The total final cost of this work was estimated in 1885 at $40,000.

Up to June 30, 1889, a total of $18,532.49 had been spent in all upon this improvement in replacing the long and crooked channel by a shorter and straighter channel of at least 40 feet bottom width and 3.5 feet depth at low water.

This new channel was used daily by the craft entering New River from the ocean, and was deepening under the scour of the river and tidal currents.

During the fiscal year ending June 30, 1890, an additional $655.69, including outstanding liabilities, was spent upon this improvement in office work, in surveys, in minor field-work, and the partial construction of an oyster-shell dike 500 feet long, to close Cedar Point Creek, just below the south mouth of Cedar Brush Marsh Cut.

This improvement, once thoroughly completed, should be comparatively permanent.

July 1, 1889, amount available		$4,467.51
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$213.82	
July 1, 1890, outstanding liabilities	441.87	
		655.69
July 1, 1890, balance available		3,811.82
Amount appropriated by act of September 19, 1890		5,000.00
Amount available for fiscal year ending June 30, 1891		8,811.82
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		12,000.00

(See Appendix M 9.)

10. *Black River, North Carolina.*—When placed under improvement in 1886 this river had a moderately well cleared channel from its mouth (in the Cape Fear River, 14 miles above Wilmington) 22 miles upwards to Point Caswell, with 2.5 feet depth at low water and 4 feet depth at high tide, thence a roughly cleared navigation 48 miles further to near Lisbon, with 2.5 feet depth during nine months per year, and with 6 feet depth during six months per year.

The original project of 1885, as continued to date, proposed to secure a fairly cleared natural channel over the entire river, from its mouth up 70 miles to near Lisbon, then a 4-foot channel below Point Caswell, and then an improved channel through the narrows. The total final cost of this work was estimated in 1885 at $33,500.

Up to June 30, 1889, a total of $2,377.24 had been spent upon this improvement in the removal of the worst obstructions over the entire river.

During the fiscal year ending June 30, 1890, an additional $519.61, including outstanding liabilities, was spent in removing the worst obstructions from the banks and from the river channel, in office duties, and in minor field-work.

After this improvement is finished its proper maintenance may cost from $1,000 to $3,000 per year.

July 1, 1889, amount available		$622.76
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$501.28	
July 1, 1890, outstanding liabilities	18.33	
		519.61
July 1, 1890, balance available		103.15
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		30,500.00

(See Appendix M 10.)

11. *Cape Fear River, North Carolina.—Above Wilmington.*—When placed under improvement in 1881 the Cape Fear River above Wilmington was navigable during the nine months of the year from Wilmington 115 miles upwards to Fayetteville, but the channel for the upper 75 miles was badly obstructed by logs, snags, overhanging trees, and shoals, and for the upper 66 miles it was full of shoals on which there was not more than 12 to 14 inches of water during the low-water season. At that time the navigation was owned by private parties.

The original project of 1881–'82, as continued to date, proposed to buy out the private owners of the river for $10,000, then to clear out its natural obstructions, and to further provide a continuous channel over its upper 66 miles by dredging and by artificially contracting its water-ways through at least thirty-two shoals. The total cost of this work was estimated in 1885 at $480,000 for a 3-foot actual channel depth up to Fayetteville during eleven or twelve months of the year.

Up to June 30, 1889, a total of $83,332.31 had been spent in all upon this improvement, giving a moderately well cleared channel over the whole length of the river, a moderately good 4-foot continuous channel during the entire year from Wilmington, 46 miles to Kelly's Cove; thence a similar 3-foot channel 27 miles further to Elizabethtown, and thence a 2-foot channel 80 feet wide 42 miles further to Fayetteville, increased to 5-foot depth from Wilmington to Fayetteville during nine months of the year.

During the fiscal year ending June 30, 1890, an additional $4,638.95, including outstanding liabilities, was spent in maintaining the existing channel, in completing surveys of shoals above Elizabethtown, in quarrying rock, and in building the same into jetties at various shoals in the river.

Work was stopped in October on account of winter high water and the near exhaustion of funds.

After this improvement is completed its proper maintenance may cost from $1,000 to $3,000 per year.

July 1, 1889, amount available		$4,917.69
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$4,558.49	
July 1, 1890, outstanding liabilities	80.46	
		4,638.95
July 1, 1890, balance available		278.74
Amount appropriated by act of September 19, 1890		15,000.00
Amount available for fiscal year ending June 30, 1891		15,278.74

Amount (estimated) required for completion of existing project.....$173,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix M 11.)

12. *Cape Fear River, North Carolina.—At and below Wilmington.*—When placed under improvement in 1829 the Cape Fear River below Wilmington had three bar entrances with least depth as follows: About 9 feet at the Baldhead Channel, 9 feet at the Rip Channel, and 10 feet at New Inlet Channel, these bars being, respectively, 9, 6, and 2 miles below the point which was then the head of the river's delta. From the head of this delta 20 miles up to Wilmington there were several shoals with a least depth of 7.5 feet at low water.

The original projects of 1827 to 1847 proposed to improve the upper 20 miles by dredging and by jetty contraction of the channel. Two hundred and three thousand two hundred and four dollars and fifty-nine cents was spent during this time in increasing the depth upon the shoals to 9.5 feet at low water, equal to that at the bar entrances. At or about this time the shore at Fort Caswell, opposite Baldhead Point, was protected by stone jetties, under an appropriation for the preservation of fortifications.

The projects of 1852 to 1857 proposed to deepen the water at the main entrance by jetties at Baldhead Point and by jetty and dike obstructions between Zeke's Island and Smith's Island, near New Inlet, and suggested the possible future necessity of closing New Inlet. One hundred and fifty-six thousand two hundred and ninety-six dollars and twenty-six cents was spent during this time upon these works, never fully completed for want of funds.

The project of 1870 proposed a crib closure of the space (4,403 feet long) between Smith's and Zeke's islands (finished in 1873) to prevent further widening of New Inlet. The projects of 1870 to 1872 proposed the complete closure of New Inlet (begun in 1875 and finished in 1881) in order to deepen the water at the main (Baldhead) bar entrance. The projects of 1872 to 1885, as continued to date, proposed the extension of the New Inlet Dam 2 miles further down the stream, to prevent the further erosion of Smith's Island at the Swashes. The project of 1875, as continued to date, proposed the occasional use of dredging upon the outer bar to assist the tidal currents in gradually localizing, straightening, deepening, and fixing the bar entrances to obtain first a 12-foot depth at low water and then a 14-foot depth. The projects of 1874 to 1881 for the 20 miles above New Inlet, as continued to date, proposed dredging and occasional diking wherever necessary across shoals, so as to secure first a 12-foot channel 200 feet wide and afterward a 16-foot channel 270 feet wide at low water over this whole length.

The total final cost of this work under the projects of 1870 to 1885 was in 1889 estimated to be $2,130,000.

New projects of 1889 (see Appendix M 22, Report of Chief of Engineers for 1889) have extended the work of the proposed improvement to obtain a depth of 20 feet at low water from Wilmington to the ocean at a total increased cost of $1,800,000.

Up to June 30, 1889, a total of $1,903,924.47 had been spent in all upon the proposed improvements of 1870 to 1885 with great success, obtaining a 15 feet to 15.5 feet least depth of water at the main bar entrance, and completing a channel of 16 feet depth, and at least 185 feet width, 28 miles further to Wilmington. This depth, combined with the average rise of tide—4.5 feet at the bar and 2.5 feet at Wilmington—is such that at that time vessels loaded to 16 feet draught (9.5 feet more

than in 1871) could readily go from Wilmington to the ocean in a single tide any day of the year.

During the fiscal year ending June 30, 1890, an additional $189,961.40, including outstanding liabilities, was spent in maintaining and deepening the new channel across the ocean bar, in widening the channels across the shoals in the upper river to the full width of 270 feet, in maintaining the existing channel at Snow's Marsh, and in cutting at this point a new channel, which is shorter than the old channel, will be more easily maintained and more easily navigated. Vessels of 18 feet draught now reach Wilmington.

Recent surveys show successful results everywhere, and 16 feet low-water depth across the bar as well as in the river channels.

After the improvement is finished, its proper maintenance may cost from $5,000 to $25,000 per year for a few years, but the improvement should be fairly permanent.

July 1, 1889, amount available		$201,075.53
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$187,599.49	
July 1, 1890, outstanding liabilities	2,361.91	
		189,961.40
July 1, 1890, balance available		11,114.13
Amount appropriated by act of September 19, 1890		170,000.00
Amount available for fiscal year ending June 30, 1891		181,114.13
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		1,655,000.00

(See Appendix M 12.)

13. *Yadkin River, North Carolina.*—The middle third of this river, the portion extending from the railroad bridge near Salisbury, 64½ miles upward, to the foot of Bean Shoal, is the only portion so far under improvement by the General Government.

When placed under improvement in 1880, this portion of the Yadkin River had its navigation completely obstructed by rock ledges, fish, and mill-dams, and numerous shoals, with a greatest depth of 1 foot at ordinary low water on some of its shoals and ledges.

The original project of 1879 proposed to secure a 2.5 to 3-foot steamboat navigation during the entire year over the 64½ miles above the Salisbury railroad bridge. The total final cost of the work necessary to give the desired depth over the entire 64½ miles, and during only mean winter stages of water (two-thirds of the year), was estimated in 1887 at $400,000.

Up to June 30, 1889, a total of $92,107.75 had been spent in all upon this improvement in securing a channel of 40 to 70 feet channel width, and from 2 to 2½ feet channel depth during mean winter stages of water (eight months of the year) from the Salisbury railroad bridge, 33 miles upward to Bailey's Ferry.

During the fiscal year ending June 30, 1890, an additional $4,342.73, including outstanding liabilities, was spent in removing rock and sand from the channel, in building rock jetties, in surveys for remaining work, and in minor work. All work in the field was suspended in October, 1889, on account of cold weather, high water, and the near exhaustion of funds.

The improvement, once thoroughly completed, should be comparatively permanent.

July 1, 1889, amount available		$4,892.25
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$4,169.73	
July 1, 1890, outstanding liabilities	173.00	
		4,342.73
July 1, 1890, balance available		549.52
Amount appropriated by act of September 19, 1890		5,000.00
Amount available for fiscal year ending June 30, 1891		5,549.52
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		5,000.00

(See Appendix M 13.)

14. *Harbor at Georgetown, South Carolina.*—When placed under improvement in 1880, this harbor had an excellent and well-protected anchorage of at least 1 mile in length, 150 feet width, and 15 feet depth. A bar of about 2,850 feet in length and with only 9 feet depth of water was the only obstacle to an otherwise good 13-foot navigation from Georgetown, 13 miles to the ocean.

The original project of 1881, as continued to date, proposed to secure a dredged channel of 200 feet bottom width and 12 feet low-water depth entirely through the bar. The total final cost of this work was estimated in 1889 at $44,500.

Up to June 30, 1889, a total of $23,842.63 had been spent in all upon this improvement, giving a through cut entirely across the bar, with 12 feet low-water depth and with a variable width of from 80 to 100 feet.

During the fiscal year ending June 30, 1890, an additional $34.94, including outstanding liabilities, was spent on this improvement.

The channel once thoroughly opened will probably be permanent.

July 1, 1889, amount available	$657.37
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	34.94
July 1, 1890, balance available	622.43
Amount appropriated by act of September 19, 1890	8,000.00
Amount available for fiscal year ending June 30, 1891	8,622.43
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	12,000.00

(See Appendix M 14.)

15. *Winyaw Bay, South Carolina.*—When placed under improvement in 1886 this bay had only 9 feet least depth upon its bar entrance, with a 12-foot channel the rest of the way to Georgetown.

The original project of 1885 proposed to secure a permanent bar entrance from 15 to 20 feet depth of water. The total final cost of this work was estimated in 1885 at $800,000 for a bar depth at 12 feet (and $2,500,000 for a bar depth of from 15 to 20 feet) at low water.

Up to June 30, 1889, a total of $6,980.26 had been spent upon this improvement in making necessary preparations for beginning work.

During the fiscal year ending June 30, 1890, an additional $13,047.19, including outstanding liabilities, was spent on this work.

Bids for the stone and mattress work and sheet piling for the North Jetty and wings were opened July 24, 1889; the contract was awarded to J. S. Howell, of New York, the lowest bidder.

The contract provided for work to be begun by November 1, 1889, and finished in twelve months from that date.

Owing to delays, which the contractor claims were unavoidable, work was not actually commenced until February 4, 1890, and since that date work has progressed slowly.

One hundred and five thousand three hundred and fifty-five and eighty-seven one hundredths feet B. M. of sheet piling have been driven and 1,016.69 tons of stone put in place on the Main North Jetty and wings.

The channel, once thoroughly opened, will probably retain its depth permanently.

July 1, 1889, amount available		$111,769.74
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$11,449.17	
July 1, 1890, outstanding liabilities	1,598.02	
July 1, 1890, amount covered by uncompleted contracts made during the fiscal year ending June 30, 1890	72,320.59	
		85,367.78
July 1, 1890, balance available		26,401.96
Amount appropriated by act of September 19, 1890		100,000.00
Amount available for fiscal year ending June 30, 1891		126,401.96
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		2,281,250.00

(See Appendix M 15.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENT, TO COMPLY WITH REQUIREMENTS OF THE RIVER AND HARBOR ACT OF AUGUST 11, 1888.

The required preliminary examination of *Roanoke River, Virginia, between Clarksville and Eaton Falls*, was made by the local engineer in charge, Captain Bixby, and reported by him as not worthy of improvement, with facts and reasons for such opinion. The Chief of Engineers, concurring in the conclusion reached in this instance, has given no instructions to make further survey with the view to its improvement. The results of this examination were transmitted to Congress and printed as House Ex. Doc. 62, Fifty-first Congress, first session. (See also Appendix M 16.)

Examinations and surveys of the following localities were made by the local engineer in charge, Captain Bixby, and reported by him as worthy of improvement, and the results were transmitted to Congress and printed in Ex. Doc's. of the Fifty-first Congress, first session:

1. *Fishing Creek, North Carolina.*—Printed as House Ex. Doc. 32. (See also Appendix M 17.)

2. *North East River (Cape Fear), North Carolina.*—Printed as House Ex. Doc. 35. (See also Appendix M 18.)

It appearing from the preliminary examination made by the local engineer that *Shallotte River, North Carolina*, is worthy of improvement, and the public necessity therefor being apparent from the facts and reasons reported, which are concurred in by the Chief of Engineers, Captain Bixby was charged with and completed its survey, the results of which were transmitted to Congress and printed as House Ex. Doc. 78, Fifty-first Congress, first session. (See also Appendix M 19.)

IMPROVEMENT OF LUMBER RIVER, NORTH CAROLINA, OF WACCAMAW RIVER, NORTH CAROLINA AND SOUTH CAROLINA, AND OF RIVERS AND HARBORS ON THE COAST OF SOUTH CAROLINA.

Officer in charge, Capt. Frederic V. Abbot, Corps of Engineers, having under his immediate orders since September 9, 1889, First Lieut. E. J. Spencer, Corps of Engineers; Division Engineer, Col. William P. Craighill, Corps of Engineers.

1. *Charleston Harbor, South Carolina.*—The work of improvement in progress since 1878 comprises two jetties composed of riprap stone resting upon a foundation mattress of logs and brush with a mattress hearting wherever deemed advantageous.

The two jetties spring respectively from Sullivan's and Morris islands, and converge on curves in such manner as to cross the bar on parallel lines about 2,900 feet from each other. The object of the work is to establish and maintain a channel across the bar of not less than 21 feet navigable depth at mean low water, where heretofore the available low-water depth has not exceeded 12 feet.

The total estimated cost for jetties up to low water is $4,380,500; for jetties up to 3 feet above mean low water, $5,334,500.

Work on the jetties has continued during the whole year under the contract of Grant & Eagan, 21,353 tons of riprap having been deposited on the outer end of the north jetty, and 34,012 tons on the south jetty outside of the main ship-channel.

This has raised the outer 3,000 feet of the north jetty practically to mean low-water mark, and 5,300 feet of the south jetty to the same level between points 7,000 feet and 12,300 feet from the shore end.

Dredging, under the contract of Byron Clark Howell, began on September 9, 1889, and continued without serious intermission till May 12, 1890, when the plant became disabled. A new dredge was supplied but was not able to begin the work till after the end of this fiscal year.

The area on which there is less than 9 feet has been largely diminished. The area of less than 12 feet at mean low water has been decreased 30 acres during the year. No material changes in the condition of the jetties are reported except such as are due to work done during the year.

Morris Island has not cut away at all. On Sullivan's Island no marked changes have occurred. The two spur-jetties built in 1884 for the protection of a portion of the shore of Mount Pleasant, are in good condition.

The total expenditures have been $1,598,599.68.

With the idea of making work more rapid and satisfactory, a good moderate-sized plant has been purchased by the United States, but this was done so late in the fiscal year that no actual work has been done with it.

July 1, 1889, amount available		$76,618.44
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$24,837.73	
July 1, 1890, outstanding liabilities	19,712.21	
		44,549.94
July 1, 1890, balance available		32,068.50
Amount appropriated by act of September 19, 1890		370,000.00
Amount available for fiscal year ending June 30, 1891		402,068.50
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		2,178,000.00

(See Appendix N 1.)

2. *Lumber River, North Carolina.*—The river is obstructed by logs, snags, stumps, overhanging trees, and in places by sand-bars. It is crossed by a number of bridges without draws. Its present commerce is small.

The project contemplates the removal of snags, logs, and overhanging trees on 98 miles below Lumberton, at an estimated cost of $35,000.

The river and harbor act of August 11, 1888, appropriated $5,000 for Lumber River, North Carolina. This precludes the removal of snags, etc., on that portion of the river which is in South Carolina. This portion is likewise obstructed by two low bridges without draws.

No work has been done during the fiscal year, as the exclusive right to navigate and improve Lumber River, North Corolina, now vests in an incorporated company, which has not yet made a satisfactory transfer of its rights to the United States, although this is promised free of cost.

Several transfer papers have been submitted, but have not met with the approval of the Department of Justice. The last one, made out by an officer of that Department, has not yet been received back signed.

The amount expended up to the close of the fiscal year ending June 30, 1890, was $2,115.77.

July 1, 1889, amount available		$4,361.58
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$1,467.35	
July 1, 1890, outstanding liabilities	37.00	
		1,504.35
July 1, 1890, balance available		2,857.23
Amount appropriated by act of September 19, 1890		5,000.00
Amount available for fiscal year ending June 30, 1891		7,857.23
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		25,000.00

(See Appendix N 2.)

3. *Mingo Creek, South Carolina.*—This stream was much obstructed by snags and overhanging trees.

The project provides for removing obstructions from the mouth to William's Landing for steam-boat navigation, and above for pole-boat navigation. The estimated cost is $17,000.

During the fiscal year ending June 30, 1889, the creek has been cleared from its mouth upwards a distance of 17 miles. Its commerce amounts to about $960,000.00.

The total expenditures to June 30, 1890, were $3,931.72.

July 1, 1889, amount available		$1,465.57
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$397.29	
July 1, 1890, outstanding liabilities	311.92	
		709.21
July 1, 1890, balance available		756.36
Amount appropriated by act of September 19, 1890		5,000.00
Amount available for fiscal year ending June 30, 1891		5,756.36
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		7,000.00

(See Appendix N 3.)

4. *Clark Creek, South Carolina.*—The creek forms the southern mouth of Lynch's River. Its upper end was entirely choked by drift-wood and fallen trees.

The project provides for closing the northern mouth of Lynch's River and snagging Clark Creek. The estimated cost is $7,500.

The river and harbor act of August 11, 1888, appropriated $2,500 for this creek, this being the first appropriation. As much work has been done as the funds allowed during the fiscal year just ended, but the improved channel has not as yet been carried entirely through. No benefit can result from it until this is done.

The total expenditures, including June 30, 1890, have been $2,463.93.

July 1, 1889, amount available		$1,932.42
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$1,896.35	
July 1, 1890, outstanding liabilities	6.00	
		1,902.35
July 1, 1890, balance available		30.07
Amount appropriated by act of September 19, 1890		2,500.00
Amount available for fiscal year ending June 30, 1891		2,530.07
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		2,500.00

(See Appendix N 4.)

5. *Ashley River, South Carolina.*—Ashley River is about 40 miles in length and runs in a generally southeasterly direction. At its mouth the city of Charleston occupies the left bank.

The plan of improvement comprises (1) the removal of a shoal at a place named Accabee, about 8 miles above the city of Charleston, where, according to a survey made in 1873, there was then only 9 feet of water at low tide, and (2) the removal of a shoal just below the Wando Phosphate Works, where only 6 feet of water was found at low tide. It was proposed to increase the draught of water over these shoals by dredging to a depth of from 10 to 11 feet at mean low tide, at an estimated cost of $5,000.

Of four appropriations made for this work, the first three, aggregating $4,500, were expended in improving the river at the places indicated, obtaining low-water depths of from 10 to 11 feet, on widths of from 100 to over 200 feet. This satisfactory condition of the river has continued during the past fiscal year, for which reason the last appropriation of $1,000 made by act approved August 5, 1886, was held in reserve until it should appear expedient or necessary to expend it. It is reported that the value of its commerce has increased by $155,000, and the tonnage by 20,000 tons.

The total amount expended, including June 30, 1890, was $4,654.

July 1, 1889, amount available	$1,005.09
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	159.09
July 1, 1890, balance available	846.00

(See Appendix N 5.)

6. *Edisto River, South Carolina.*—The Edisto River is formed by the junction of the North and South Forks, which unite in the southern part of Orangeburgh County. The South Fork, commonly known as the South Edisto, is the main river.

The obstructions to navigation consist of numerous bends, logs, snags,

overhanging trees, and piles. Also of shoals, generally of sand, but in some places of hard clay and rock.

The plan of improvement contemplates the establishment of a channel available at all seasons of the year, for rafts and flat-boats, from the sea, 260 miles, to Guignard's Landing.

It embraces shutting off lateral arms of the river, removing shoals, snags, logs, piles, and other obstructions. The cost is estimated at $33,385.

The work heretofore done comprises the removal of a large number of snags, logs, overhanging trees, and piles in the reaches within 180 miles of the mouth of the river. The improvement of several sucks, the closure of incipient cut-offs and outlets and trimming the banks. This work has materially benefited navigation by shortening the time and reducing the expense of trips.

Work was resumed in October, 1889. The improvement was extended up-stream for about 47 miles above the point at which previous work had stopped.

The total expenditures up to June 30, 1890, were $20,663.50.

July 1, 1889, amount available		$2,709.46
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$2,372.96	
July 1, 1890, outstanding liabilities	2.00	
		2,374.96
July 1, 1890, balance available		334.50
Amount appropriated by act of September 19, 1890		5,000.00
Amount available for fiscal year ending June 30, 1891		5,334.50
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		7,385.00

(See Appendix N 6.)

7. *Salkahatchie River, South Carolina.*—The Salkahatchie River rises in Aiken County, South Carolina, and flows into the Atlantic Ocean. The lower part of the river is known as the Combahee. Above a point named Hickory Hill the river was obstructed at numerous places by piles, logs, trees and sand-bars. The project of improvement contemplated the removal of these obstructions for the purpose of establishing a continuous channel suitable for rafts and flat boats from a point 5 miles above Toby's Bluff down to Hickory Hill. The cost of the project was estimated at $18,000. The work done comprises thoroughly clearing the lower 12 miles reach of the Salkahatchie River between Hickory Hill and the Charleston and Savannah Railroad Bridge, and improving the reaches from that bridge to Broxton's Bridge. A substantial improvement of the river is reported.

The total expenditures to June 30, 1890, were $12,754.85.

July 1, 1889, amount available		$1,472.48
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$1,227.33	
July 1, 1890, outstanding liabilities	2.00	
		1,229.33
July 1, 1890, balance available		243.15
Amount appropriated by act of September 19, 1890		5,000.00
Amount available for fiscal year ending June 30, 1891		5,243.15

(See Appendix N 7.)

8. *Little Pee Dee River, South Carolina.*—The river was much obstructed by snags and overhanging trees, and in places it was subdivided into several branches. The project provides for removing obstructions, and closing unnecessary branches. Steam-boat navigation is provided for to the Lumber River, and pole-boat navigation above to Little Rock. The estimated cost is $50,000.

During the past fiscal year snags were removed from all points of the river covered by the project. Its commerce amounts to about $34,737.

The total expenditures to June 30, 1890, were $4,582.78.

July 1, 1889, amount available		$1,554.85
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$1,127.63	
July 1, 1890, outstanding liabilities	109.82	
		1,237.45
July 1, 1890, balance available		307.40
Amount appropriated by act of September 19, 1890		5,000.00
Amount available for fiscal year ending June 30, 1891		5,307.40
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		40,000.00

(See Appendix N. 8.)

9. *Great Pee Dee River, South Carolina.*—This river was dangerously obstructed by snags and logs. The project provides for a thoroughly cleared 9-foot navigation up to Smith's Mills, and a 3½-foot navigation to Cheraw, 172 miles above the mouth at all stages of water. At ordinary stages of water there is a well-cleared 9-foot channel up to Smith's Mills, and a fairly cleared 3½-foot channel at low water 50 miles further or at high water to Cheraw. During the fiscal year ending June 30, 1890, a large amount of snagging has been done. Substantial improvement has resulted. The total expenditures up to June 30, 1890, were $63,841.79.

July 1, 1889, amount available		$12,238.91
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$9,080.70	
July 1, 1890, outstanding liabilities	627.63	
		9,708.33
July 1, 1890, balance available		2,530.58
Amount appropriated by act of September 19, 1890		12,500.00
Amount available for fiscal year ending June 30, 1891		15,030.58
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		37,500.00

(See Appendix N 9.)

10. *Santee River, South Carolina.*—This river was obstructed at all stages of water by sunken logs, snags, and floating timbers. Its bar entrance was narrow, crooked, and shifting, with only about 4 feet depth at low tide, and so situated as to be difficult and expensive to improve. The total final cost of this work was estimated in 1886, as $346,500, of which $251,300 was for Mosquito Creek, and $75,200 for the Santee River proper.

During the past fiscal year the contract for dredging in Mosquito Creek was completed, as well as the work on a second drainage ditch designed to prevent the entrance of ocean water into the canal.

Up to June 30, 1890, $94,492.34 has been spent upon this improvement in opening a passage at least 30 feet wide, 5 feet deep at high water from Mosquito Creek to Winyah Bay, and in making necessary surveys of the whole improvement, in building a draw-bridge over the creek in accordance with the provisions of the cession of the right of way, and in replacing rice drainage injured by digging the canal. The effect of this work upon the rice interests in the neighborhood has been and will be beneficial rather than detrimental.

July 1, 1889, amount available		$6,837.63
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,579.97	
July 1, 1890, outstanding liabilities	60.00	
		$1,639.97
July 1, 1890, balance available		5,197.66
Amount appropriated by act of September 19, 1890		30,000.00
Amount available for fiscal year ending June 30, 1891		35,197.66
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		216,750.00

(See Appendix N 10.)

11. *Wateree River, South Carolina.*—This river had a low-water depth of from 3 to 4 feet from its mouth in the Santee, upward 68 miles, to Camden, its practicable limit of steam navigation. From its mouth upward 14 miles the river was completely blocked at all stages of water by sunken logs, stumps, and by floating obstructions, and at moderate stages by the bridges of the South Carolina, and Wilmington, Columbia and Augusta Railroads without draws. This 54 miles to Camden, navigation was possible, but dangerous except during high water.

The original project proposed to secure a safe and unobstructed 4-foot navigation over this entire distance at all stages of water.

But little work has been done under the appropriation of August 11, 1888, as the South Carolina Railroad was very slow about putting in a draw-span, and the law prevented any work until this had been approved by the Secretary of War. Up to June 30, 1890, a total of $39,770.72 has been spent upon this improvement, giving a thoroughly cleared 4-foot navigation at all stages of water from the mouth of the river 11 miles upward, and thence a fairly well cleared 4-foot navigation over the rest of the river 57 miles to Camden.

July 1, 1889, amount available		$12,164.33
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$4,435.05	
July 1, 1890, outstanding liabilities	583.00	
		5,018.05
July 1, 1890, balance available		7,146.28
Amount appropriated by act of September 19, 1890		12,500.00
Amount available for fiscal year ending June 30, 1891		19,646.28

(See Appendix N 11.)

12. *Congaree River, South Carolina.*—This river had a low-water depth of from 3 to 4 feet from its mouth 48 miles upward to the railroad bridge at Columbia, and thence a 1-foot low-water depth 2 miles further to its head, the navigation of the lower 47 miles from the mouth upward to Granby being blocked at all stages of water by the South Carolina Railroad Bridge, without a draw, and by sunken logs, snags, overhanging trees, and the navigation of the upper 3 miles above

Granby being prevented by a swift current and numerous rock-ledges and bowlders.

The project proposes to secure a thoroughly cleared channel 4 feet deep at all stages below Granby and a cleared channel 100 feet wide through the shoals above.

Work began in February, 1890, at which time the approval of the Secretary of War was obtained for the draw-span of the South Carolina Railway Bridge. It has been carried on over the whole length of the river between Granby and its mouth. Much good has resulted. Up to June 30, 1890, a total of $12,910.99 has been spent on this improvement, giving a thoroughly well cleared navigation of 70 feet width and 4 feet depth at low water over the entire river below Granby.

July 1, 1889, amount available		$7,564 35
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$5,475.34	
July 1, 1890, outstanding liabilities	438.83	
		5,914.17
July 1, 1890, balance available		1,650.18
Amount appropriated by act of September 19, 1890		5,000.00
Amount available for fiscal year ending June 30, 1891		6,650.18
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		34,500.00

(See Appendix N 12.)

13. *Wappoo Cut, South Carolina.*—Wappoo Cut is a narrow, crooked, tidal stream, separating James Island from the mainland and connecting Stono and Ashley rivers.

The project comprises securing a channel 60 feet wide and 6 feet deep at low water, training-walls at the Stono River entrance, revetting the banks of Elliott's Cut with stone, making another cut through the marsh, constructing three more closing dams, and dredging Ashley River Bar. There is practically a continuous 6-foot channel through from Ashley to Stono River at low water. This is narrow in some places. The total amount expended to June 30, 1890, is $31,354.00.

July 1, 1889, amount available	$1,650.00
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	4.00
July 1, 1890, balance available	1,646.00
Amount appropriated by act of September 19, 1890	10,000.00
Amount available for fiscal year ending June 30, 1891	11,646.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	45,000.00

(See Appendix N 13.)

14. *Waccamaw River, North Carolina and South Carolina.*—In 1880 this river was navigable for 12-foot draught boats, at all stages of water, from Georgetown, 26 miles to Bull Creek, and at high water 6 miles further to Buck's Lower Mills Thence for 7-foot draught boats at high water 31 miles further to Conway; thence it possessed an obstructed channel for 3-foot draught boats, at ordinary winter water, 109 miles to Reeves Ferry, the present head of steam navigation; thence an obstructed channel, with 3 feet depth at high water, 42 miles to Lake Waccamaw.

The commerce of this river is estimated to have been about $400,000 per year.

The project provides for a channel 12 feet deep at all stages of water and 80 feet bottom width from the mouth of the river to Conwayboro, thence a cleared channel to Lake Waccamaw. During the fiscal year ending June 30, 1890, a large amount of snagging has been done. Much good has resulted. Up to June 30, 1890, $65,175.13 has been spent on this river, giving a thoroughly cleared channel with 100 feet least width and 8.8 feet least depth at high water, 7 feet at low water, as far as Conway, and with 45 feet width and 3 feet depth 72 miles above Conway.

July 1, 1889, amount available		$5,436.42
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$5,211.55	
July 1, 1890, outstanding liabilities	50.00	
		5,261.55
July 1, 1890, balance available		174.87
Amount appropriated by act of September 19, 1890		12,500.00
Amount available for fiscal year ending June 30, 1891		12,674.87
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		60,500.00

(See Appendix N 14.)

15. *Removing sunken vessels or craft obstructing navigation.*—During the past fiscal year the wreck of a vessel, name unknown, loaded with guns and shot, was partially removed from the South Channel across Charleston, S. C., Bar. Work was still in progress at the end of fiscal year.

(See Appendix N 15.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENT TO COMPLY WITH REQUIREMENTS OF RIVER AND HARBOR ACT OF AUGUST 11, 1888.

It appearing from the preliminary examination made by the local engineer that the following localities are worthy of improvement, and the public necessity therefor being apparent from the facts and reasons reported, which are concurred in by the Chief of Engineers, Captain Abbot was charged with and completed their survey, the results of which were transmitted to Congress and printed in Ex. Doc's. of the Fifty-first Congress, first session:

1. *Beaufort River from a point 3 miles south of the town of Beaufort through to Coosaw River, with view to its improvement, especially at Brickyard, South Carolina.*—Printed as House Ex. Doc. 42. (See also Appendix N 16.)

2. *Owendaw and Wando rivers and other waters and water-routes connecting Bull's Bay and the harbor of Charleston, South Carolina.*—Printed as House Ex. Doc. 82. (See also Appendix N 17.)

IMPROVEMENT OF CERTAIN RIVERS AND HARBORS IN GEORGIA, AND OF CUMBERLAND SOUND, GEORGIA AND FLORIDA.

Officer in charge, Lieut. O. M. Carter, Corps of Engineers, with Lieut. Thos. H. Rees, Corps of Engineers, under his immediate orders since October 12, 1889; Division Engineer, Col. William P. Craighill, Corps of Engineers.

1. *Savannah River and Harbor, Georgia.*—The plan according to which operations have up to the present time been carried on in the Savannah Harbor and River was adopted in 1873, and modified and enlarged in 1879 and again in 1882. It contemplated the establishment of a channel from Tybee Roads to the city of Savannah, navigable at high water for vessels of 22 feet draught, and the widening of the river opposite the city to 600 feet, of uniform depth with the balance of the channel. The cost was originally estimated at $482,000, and as amended and enlarged at $1,212,000.

The cost of obtaining a channel 26 feet deep at mean high water from the city to the sea is estimated at $3,500,000.

In 1873, prior to improvement, the channel was in places not more than 9 feet deep at mean low water, and the usual high-water draught of vessels was not more than 14.5 feet.

During the fiscal year just closed 14,006.25 square yards of log and brush mattresses, 3,574.34 cubic yards of stone, and 308.57 cubic yards of oyster shells have been used in the oyster-bed training-wall. In the Fig Island training-wall 495.78 cubic yards of brush fascines, 5 cubic yards of oyster shells, and 223.45 cubic yards of stone have been used, and 350 cubic yards of stone removed and handled.

Between the ocean steam-ship wharves and upper flats crossing 31,551 cubic yards of material have been dredged. The hydrographic survey of the river has been completed and a report thereon submitted together with a revised project for the improvement of the harbor. The expenditures during the year amounted to $70,357.26.

The total amount expended to June 30, 1890, including all outstanding liabilities, is $1,208,122.39, and has resulted in securing a navigable channel from the city to the sea with a least mean low-water depth 13 feet, a gain of 4 feet since the work was begun.

The gain in navigable depth is somewhat greater than here shown, and vessels of from 20 to 21 feet draught now go from the city to the sea on a single tide.

The estimated reduction in freight rates, due to the improvements already executed, is 25 per cent., which effects an annual saving in freights alone of more than the total sum of money expended by the United States upon the harbor within the last twenty-five years.

July 1, 1889, amount available		$41,335.45
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$37,300.40	
July 1, 1890, outstanding liabilities	157.44	
		37,457.84
July 1, 1890, balance available		3,877.61
Amount appropriated by act of September 19, 1890		350,000.00
Amount available for fiscal year ending June 30, 1891		353,877.61
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		3,150,000.00

(See Appendix O 1.)

2. *Savannah River, Georgia.*—The project for the improvement of this river was adopted in 1880, the object being to secure a low-water steam-boat channel not less than 5 feet in depth between the cities of Augusta and Savannah, Ga.

The cost of the improvement was originally estimated at $91,000, and in 1887, for reasons given in the Annual Report of that year, at

$176,000. Prior to the improvement navigation was much impeded by logs, snags, piles, and other obstructions. The depth at summer low water over some of the shoals did not exceed 2 or 3 feet.

A survey of the river was completed August 6, 1889, and a report thereon has been submitted together with a revision of the project for the improvement of the river. The expenditures during the year amounted to $16,379.70. The total amount expended to June 30, 1890, including all outstanding liabilities, is $93,480.09, and has resulted in improving the condition of the shoals near Augusta, and in removing the most dangerous obstructions to navigation throughout the whole extent of the river, no accidents to steam-boats having occurred since these obstructions were removed.

July 1, 1889, amount available	$14,896.27
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	14,876.36
July 1, 1890, balance available	19.91
Amount appropriated by act of September 19, 1890	25,000.00
Amount available for fiscal year ending June 30, 1891	25,019.91
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	307,000.00

(See Appendix O 2.)

3. *Savannah River, above Augusta, Georgia.*—The project for the improvement of this river was adopted in 1879, the object being to secure a low-water pole-boat channel, 30 feet in width and 3 feet in depth, between Augusta and Trotter's Shoals, 64 miles above. The cost of the improvement, which was not based upon accurate surveys, was estimated at $45,000.

The obstructions to navigation consisted chiefly of rock ledges running across the channel, bowlders of various sizes, and shoals of gravel, with depths at low-water stage of from 1 to 2 feet.

No work has been done upon this river since August, 1883.

A survey of the river was made in October, 1889. A report thereon was submitted January 31, 1890, together with a project for the improvement of the river below Petersburgh, with a view to obtaining a channel 12 to 25 feet in width for boats drawing 2 feet of water. The cost was estimated at $33,000.

The expenditures during the year amounted to $653.02. The total amount expended to June 30, 1890, including all outstanding liabilities, is $39,000, and has resulted in improving the medium stage channel through a few of the rock ledges and in removing some of the most dangerous bowlders obstructing navigation. No additional commerce has been developed upon the stream by the work done, nor have freight rates been appreciably reduced by that cause.

July 1, 1889, amount available	$653.02
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	653.02
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	33,000.00

(See Appendix O 3.)

4. *Romley Marsh, Georgia.*—The project for the improvement of this locality was adopted in 1880 the object being to open a cut, with a minimum bottom width of 48 feet, and a mean low-water depth of 7 feet,

between Dead Man's Hammock Creek on the north and Wassaw Creek on the south. The cost was estimated at $38,720.

The natural channel is extremely crooked and difficult to navigate, and at the shoalest part not more than 3.5 feet deep at mean low water. No work was done during the last fiscal year. The expenditures during the year amounted to $172.55.

The total amount expended to June 30, 1890, including all outstanding liabilities, is $47,108.77, including $5,000 advanced by private parties, and has resulted in the completion of the work, securing a navigable channel between Wassaw and Ossabaw sounds with a low-water depth of not less than 5 feet.

July 1, 1889, amount available	172.55
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	172.55

(See Appendix O 4.)

5. *Altamaha River, Georgia.*—The present project for the improvement of this river was adopted in 1880, the object being to secure a steam-boat channel 80 feet in width and 3 feet in depth at low-water stage between Darien, Ga., and the junction of the Oconee and Ocmulgee rivers. The cost of the improvement was originally estimated at $60,000, and in 1884 at $75,000.

Prior to improvement navigation was much impeded by logs, snags, and other obstructions, the low-water depth at some points not exceeding 2 feet.

During the fiscal year just closed 171 snags and logs and 309 overhanging trees were removed.

A survey of the river was completed in October, 1889, and a report thereon has been submitted, together with a revision of the project for the improvement of the river. The estimated cost of the improvement is $128,627.50.

During the year the expenditures amounted to $5,592.16.

The total amount expended to June 30, 1890, including all outstanding liabilities, is $64,776.59, and has resulted in removing the most dangerous obstructions, interruptions to steam-boat navigation having occurred during the year only at Beard's Bluff Bar.

July 1, 1889, amount available	$5,815.57
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	5,592.16
July 1, 1890, balance available	223.41
Amount appropriated by act of September 19, 1890	15,000.00
Amount available for fiscal year ending June 30, 1891	15,223.41
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	113,627.50

(See Appendix O 5.)

6. *Oconee River, Georgia.*—The present project for the improvement of this river was adopted in 1878 and revised in 1880 and again in 1888, the object being to secure a low-water channel 3 feet in depth from Milledgeville to the mouth of the river. The cost of the improvement was originally estimated at $10,500, and in 1888 at $100,000.

Prior to improvement navigation was much impeded by sand-bars, overhanging trees, snags, and sunken logs. On some shoals there were low-water depths of not more than 2 feet. During the fiscal year just

closed 948 logs and snags and 15,220 overhanging trees were removed; 511 trees were deadened, and 229 logs were cut up on the bank.

A survey of the river was made in October, 1889, and a report thereon has been submitted, together with a revision of the project for the improvement of the river.

The expenditures during the year amounted to $10,524.84. The total amount expended to June 30, 1890, including all outstanding liabilities, is $44,822.18, and has resulted in so improving the river that boats now run at a stage of water 4 feet lower than before the improvements were begun.

July 1, 1889, amount available		$10,357.19
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$10,156.01	
July 1, 1890, outstanding liabilities	23.36	
		10,179.37
July 1, 1890, balance available		177.82
Amount appropriated by act of September 19, 1890		25,000.00
Amount available for fiscal year ending June 30, 1891		25,177.82
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		146,000.00

(See Appendix O 6.)

7. *Ocmulgee River, Georgia.*—The present project for the improvement of this river was adopted in 1876, and revised in 1882, and again in 1886, the object being to secure a low-water channel 60 feet in width and 4 feet in depth from Macon to the mouth of the river. The cost of improvement was originally estimated at $56,240, and in 1886 at $112,480.

Prior to improvement navigation was much impeded by rock shoals, sand-bars, overhanging trees, snags, and sunken logs, the low-water depth at some places not exceeding 2 feet.

A survey of the river was made in October, 1889, and a report thereon has been submitted, together with a revision of the project for the improvement of the river.

During the fiscal year just closed 1,829 snags and logs and 7,683 overhanging trees were removed, 615 trees were deadened, and 25 logs cut up on the river-bank. The expenditures during the year amounted to $12,002.13. The total amount expended to June 30, 1890, including all outstanding liabilities, is $79,390.73, and has resulted in removing many dangerous obstructions, boats now being able to run without accident at a stage of water some 3 feet lower than before the improvements were begun.

July 1, 1889, amount available		$11,518.30
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$11,273.35	
July 1, 1890, outstanding liabilities	135.68	
		11,409.03
July 1, 1890, balance available		109.27
Amount appropriated by act of September 19, 1890		30,000.00
Amount available for fiscal year ending June 30, 1891		30,109.27
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		180,000.00

(See Appendix O 7.)

8. *Brunswick Harbor, Georgia.*—The present project for the improvement of this harbor was adopted in 1880 and modified and enlarged in 1886, the object being to secure a navigable channel not less than 15 feet deep at mean low water. The mean rise and fall of tide is 6.8 feet. The cost of the project of 1880 was estimated at $73,187.50 and as enlarged in 1886 at $190,000, inclusive of appropriations already made.

In 1880, prior to improvement, the channel was not more than 9 feet deep at mean low water.

During the fiscal year just closed 29,096.27 cubic yards were dredged from the channel, and 3,714.36 cubic yards of brush fascines and 619.48 cubic yards of stone placed in the training-wall.

The expenditures during the year amounted to $22,328.89. The amount expended to June 30, 1890, including all outstanding liabilities, is $127,457.73, and has resulted in securing a navigable low-water channel not less than 15 feet deep.

July 1, 1889, amount available	$15,793.26
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	15,750.99
July 1, 1890, balance available	42.27
Amount appropriated by act of September 19, 1890	35,000.00
Amount available for fiscal year ending June 30, 1891	35,042.27

(See Appendix O 8.)

9. *Jekyl Creek, Georgia.*—The present project for the improvement of this creek was adopted in 1888, the object being to obtain a navigable channel through the creek 7 feet deep at mean low water. The cost of improvement was estimated at $38,500.

Prior to improvement the low-water depth at some places did not exceed 3 feet, with a mean rise and fall of tide of 7.1 feet.

No work was done during the fiscal year just closed. The expenditure during the year amounted to $209.92. The amount expended to June 30, 1890, including all outstanding liabilities, is $4,968.62, and has resulted in securing a navigable channel with a low-water depth of not less than 5 feet.

It is proposed during the coming year to complete the dredging and begin work on the training-wall and closing-dam.

July 1, 1889, amount available	$233.05
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	201.67
July 1, 1890, balance available	31.38
Amount appropriated by act of September 19, 1890	7,500.00
Amount available for fiscal year ending June 30, 1891	7,531.38
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	26,090.00

(See Appendix O 9.)

10. *Cumberland Sound, Georgia and Florida.*—The present project for the improvement of the entrance to this sound was adopted in 1879, the object being to secure a navigable low-water channel across the bar from 20 to 21 feet in depth. The cost of improvement was estimated at $2,071,023.

Prior to improvement the low-water depth of the entrance varied from 11 to 12.5 feet, with a mean rise and fall of tide of 5.9 feet.

During the fiscal year just closed there were placed in the south jetty 18,060.62 cubic yards of stone and 817.93 cubic yards of shells, raising

it to the level of mean low water for a distance of about 880 feet. The expenditures during the year amounted to $79,006.48. The total amount expended to June 30, 1890, including all outstanding liabilities, is $479,550.28.

July 1, 1889, amount available	$66,383.76
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	65,934.04
July 1, 1890, balance available	449.72
Amount appropriated by act of September 19, 1890	112,500.00
Amount available for fiscal year ending June 30, 1891	112,949.72
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	1,478,500.00

(See Appendix O 10.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENT TO COMPLY WITH REQUIREMENTS OF RIVER AND HARBOR ACT OF AUGUST 11, 1888.

It appearing from the preliminary examination made by the local engineer that the following localities are worthy of improvement, and the public necessity therefor being apparent from the facts and reasons reported, which are concurred in by the Chief of Engineers, Lieutenant Carter was charged with and completed their survey, the results of which were transmitted to Congress and printed in Ex. Doc's. of the Fifty-first Congress, first session.

1. *Oconee River, Georgia.*—Printed as House Ex. Doc. 211. (See also Appendix O 11.)

2. *Ocmulgee River, Georgia.*—Printed as House Ex. Doc. 215. (See also Appendix O 12.)

3. *Savannah River above Augusta and between Augusta and Andersonville.*—Printed as House Ex. Doc. 213. (See also Appendix O 13.)

IMPROVEMENT OF CERTAIN RIVERS AND HARBORS IN THE STATE OF FLORIDA.

Officer in charge, Capt. William M. Black, Corps of Engineers, with Lieut. D. Du B. Gaillard, Corps of Engineers, under his immediate orders; Division Engineer, Col. William P. Craighill, Corps of Engineers.

1. *St. John's River, Florida.*—Operations for the improvement of this river have been carried on in conformity with a project submitted in 1879 by the late General Gillmore, Colonel Corps of Engineers. The plan contemplates the formation of a continuous channel 15 feet deep at mean low water from Jacksonville to the ocean. The points where work is required are in a reach near Dame's Point, 12 miles from the mouth, and on the bar at the mouth. Near Dame's Point the mean low-water depth varies from 12 to 13 feet, with a tidal range of 1 to 2 feet. The bar at the mouth is formed of sand. Before work began the mean low-water channel depth across it varied from 5 to 7 feet, with a tidal range of 6 feet. The channel across the bar shifted continually north and south through a mile range. The work was divided in two parts: (1) the formation of a channel across the bar at the mouth, by the concentration and direction of the tidal currents by two jetties, to start from the opposite shores of the entrance, and to converge until, on the bar, their outer ends should be approximately parallel and 1,600 feet apart; and (2) the improvement of the Dame's Point Reach.

As the improvement at the mouth was at first most urgently required, the five appropriations up to that of 1886, inclusive, aggregating $675,000, were made for improving "the channel over the bar at the mouth," under the estimate for that part of the total project. Since 1887 the depth on the bar has been greater than that in the Dame's Point Reach, and the interests of commerce have demanded that work at the latter point should be started. Accordingly, the appropriation in the act of August 11, 1888, was made for improving the river "from Jacksonville to the ocean, including the channel over the bar at the mouth," under the estimate for the entire project.

At the close of the fiscal year ending June 30, 1889, $751,199.01 had been expended. The south jetty had a total length of 6,667 feet of which 4,100 feet from the shore out was built to the level of mean low water. The crest of the remainder was about 6 feet below the level of mean low water. The total length of the north jetty was 8,042.2 feet. Of this 553 feet, from the shore end out, was built to the full height and capped. For 6,144 feet more it had a crest varying in width from 12 to 20 feet at the level of mean low water. The crest of the remainder was from 3 to 10 feet below mean low-water level. During the past fiscal year, the jetty construction was continued under the contract until November, when the sum allotted for this portion of the work was exhausted. The work of the survey of the Dame's Point Reach was plotted. The shore extension of the south jetty was built, and the inner end of the jetty was raised to the full height. This last work was done by hired labor with materials purchased by contract or in open market, as was most economical and advantageous. The total length of the south jetty is 7,147 feet. Of this 1,740 feet from the shore end out is at the full height. Two thousand seven hundred and forty feet further has its crest at the level of mean low water, and the crest of the remainder is from 1 to 5 feet below that level. The north jetty is 9,048 feet long. Its inner end for 553 feet is at the full height and capped. For 6,404 feet further its crest is at the level of mean low water. For the remaining distance the crest is at a level of from 1 to 6 feet below mean low water. The condition of the jetties is stable. After about six months' immersion the stones are covered with a growth of shellfish which soon bonds them together. Owing to their exposed position the jetties can not be built of ordinary light riprap above the level of mean low water.

The work of the jetties during the past fiscal year on the shoal between them has been very marked. The north jetty channel, which occupies a position favorable for permanence, has widened and extended seaward. The shoal known as Ward's Bank, which obstructed the mouth of the jetties, has been diminished in area, lowered, and pushed to the south and out. The extension of the north channel, however, necessarily has been attended by a diminution of the width of the south channel, the present ship-channel.

July 1, 1889, amount available		$41,259.08
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$18,164.57	
July 1, 1890, outstanding liabilities	1,159.76	
July 1, 1890, amount covered by uncompleted contracts made during fiscal year ending June 30, 1890	1,733.34	
		21,057.67
July 1, 1890, balance available		20,201.41
Amount appropriated by act of September 19, 1890		170,000.00
Amount available for fiscal year ending June 30, 1891		190,201.41

Amount (estimated) required for completion of existing project..... Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	$470,000.00

(See Appendix P 1.)

2. *Volusia Bar, Florida.*—Volusia Bar is situated at the head of Lake George, and is formed by materials brought down by the St. John's River and deposited at the point where the current of the narrow river loses its velocity as the bed widens to form the lake. The usual depth on the bar, before operations began, was from 3½ to 4½ feet, with a very crooked channel. At times this depth was diminished so much as to stop navigation entirely.

The adopted plan of improvement was to contract the waters on the bar by the construction of two converging jetties formed of brush and stone, with a view to causing a scour to the depth of 6 feet. Should the depth caused by the jetties not be sufficient, recourse was to be had to dredging. Between the jetties on the bar, lines of guide-piles were placed to keep vessels off the jetties, and to define the channel clearly.

In 1887 it was decided to limit the channel depth sought to the 5 feet then obtained, on account of the evident shoaling in the lake beyond the jetties, and because that depth was sufficient for the requirements of the existing river commerce.

Up to June 30, 1889, $24,795.50 had been expended, including liabilities then outstanding. The jetties had been built to their full length and to a height sufficient to produce the desired effect; two lines of firmly set fender-piles defined the jetty channel on the crest of the bar, and a straight channel with a minimum mean low-water depth of 5 feet had been obtained. In the spring of 1890 the crests of both jetties were found to have been lowered slightly, and several gaps had been made through them to a depth of 4 feet in one place. One hundred cubic yards of rock were placed on the jetties filling the lowest places.

In December, 1889, one of the river steamers broke out one of the panels of the west pile fender-line. This has not been repaired. The 5-foot channel across the bar has been maintained.

July 1, 1889, amount available.....		$704.50
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889.....	$659.02	
July 1, 1890, outstanding liabilities.....	27.25	
		686.27
July 1, 1890, balance available.....		18.23
Amount appropriated by act of September 19, 1890.....		500.00
Amount available for fiscal year ending June 30, 1891.....		518.23
Amount (estimated) required annually for maintenance of work..... Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		500.00

(See Appendix P 2.)

3. *Harbor at Saint Augustine, Florida.*—In compliance with the requirements of the river and harbor act of August 5, 1886, an examination and survey were made of "St. Augustine for a deep-sea channel on the outer bar," and the report of the results thereof was transmitted to Congress January 11, 1888, and printed in House Ex. Doc. No. 87, Fiftieth Congress, first session.

The project proposed for the improvement of the entrance is to concentrate the flow over the bar, and thus increase the scour by the con-

struction of solid converging jetties, etc., at an estimated cost of $1,467,888.

The river and harbor act of August 11, 1888, appropriated $35,000 for improving the harbor, but directed that the subject be referred to a Board of Engineers, whose report was to be laid before Congress at its next session, together with the views of the Secretary of War and of the Chief of Engineers thereon. The report called for was duly submitted and is printed in House Ex. Doc. No. 138, Fiftieth Congress, second session. The Board "is of the opinion that the plan is well considered and promises success should funds be supplied with sufficient liberality to permit the work to be carried rapidly to completion." The Board did not recommend the immediate prosecution of this work, but recommended that the appropriation of $35,000 be applied toward stopping the erosion of the shores at the entrance to the harbor.

The approved project submitted in accordance with this recommendation provided for the construction of spur-jetties or groins of concrete and riprap on brush foundation mattresses, with suitable wing-walls of riprap. Work under the project was begun in October, 1889, and was discontinued June 30, 1890. Three groins were built, one 341 feet long on Anastasia Island near the light-house; one 548.87 feet long on the east side of the north point, 2,000 feet from the point, and one 405 feet long directly on the point. They have all been successful in their operation and have built out the shore-lines in their vicinity. To complete the protection the engineer officer in charge states that the main groin on the north point should be extended, and two new groins built, one between the two on the north point and one on Anastasia Island, immediately opposite the point, with such intermediate lighter works as may be required.

July 1, 1889, amount available		$34,371.07
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$32,688.93	
July 1, 1890, outstanding liabilities	541.47	
		33,230.40
July 1, 1890, balance available		1,140.67
Amount appropriated by act of September 19, 1890		20,000.00
Amount available for fiscal year ending June 30, 1891		21,140.67
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		10,000.00

(See Appendix P 3.)

4. *Northwest entrance, Key West Harbor, Florida.*—A bar having a channel depth of 10.5 feet obstructs the northern entrance to this harbor. During storms the available depth is so much reduced that vessels bound to and from Gulf ports can not use it, but are compelled to make a detour of about 100 miles by Dry Tortugas to enter or leave the Gulf.

An examination of the entrance, with a view to its improvement, was made in 1867 and again in 1881. In 1882, Congress made an appropriation of $25,000 for dredging a channel 300 feet wide and 17 feet deep across the bar. As was anticipated, the improvement was only temporary.

In act approved August 5, 1886, $2,500 was appropriated for a new examination and survey of the bar. This was made in December, 1886, and January, 1887. The bar was found to be formed and maintained by interfering tidal currents. The project for its improvement comprised

the construction of one or more training-walls, with dredging, if necessary.

In the act of August 11, 1888, Congress appropriated $25,000 for this work, with the proviso that the Secretary of War should appoint a Board of three engineer officers, who should consider the subject and report on the advisability of continuing the work under the above project, and that he should submit the report, together with the views of himself and the Secretary of War thereon, to Congress at its next session.

A report was submitted and is printed in House Ex. Doc. No. 145, Fiftieth Congress, second session. The opinion of the Board is that the work is one of national importance which it is expedient to undertake, and that the general method proposed promises success at a cost within reasonable limits, but that owing to the difficulty of the problem and the small sum which had been appropriated for its investigation, the data available were insufficient for fixing the details of the project. The engineer officer in charge was directed to obtain the additional information desired. The necessary field work was done in April, May, June, and a part of September.

The Board submitted a final report on November 2, 1889. This was forwarded to Congress on December 3.

The immediate construction of a single jetty on the east side of the channel was recommended. It was further stated that "either the project should not be undertaken or $500,000 should be provided from the start."

July 1, 1889, amount available	$19,028.32
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,936.69
July 1, 1890, balance available	17,091.63
Amount appropriated by act of September 19, 1890	40,000.00
Amount available for fiscal year ending June 30, 1891	57,091.63
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	460,000.00

(See Appendix P 4.)

5. *Caloosahatchee River, Florida.*—Before improvement the lower part of the river was so obstructed by oyster bars that the available channel depth was only 5½ feet. About 17 miles above the mouth the river loses the characteristics of an estuary, and there are numerous islands and a broad shoal.

The project adopted in 1882 called for the formation, by dredging, of a channel 100 feet wide and 7 feet deep, from the bay to Fort Myers, a distance of 17 miles. In 1886 this project was modified so as to include the improvement of the upper river as far as Fort Thompson by removal of snags and overhanging trees.

Up to the close of the fiscal year ending June 30, 1889, $14,761.18 had been expended under these projects. A channel of the required width and having a least depth of 6 feet had been formed below Fort Myers; one of the worst reaches of the river, extending 4½ miles above Fort Denaud, had been cleared of snags and overhanging trees, and a survey of the river had been made.

Operations during the past fiscal year consisted in dredging a cut 35 feet wide and 5 feet deep through the shoals at the Beautiful Islands; in removing all of the worst obstructions as far as Fort Thompson, and

in beginning the construction of a training-wall at Beautiful Island Shoals.

The river is now navigable as far as Fort Thompson. With the money now available the training-wall at Beautiful Island will be completed and the dredged cut widened. After the project is completed, a small expenditure will be required annually to keep the river clear.

July 1, 1889, amount available		$9,238.82
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$5,393.35	
July 1, 1890, outstanding liabilities	1,195.54	
July 1, 1890, amount covered by uncompleted contracts made during the fiscal year ending June 30, 1890	1,082.00	
		7,670.87
July 1, 1890, balance available		1,567.93
Amount appropriated by act of September 19, 1890		3,600.00
Amount available for fiscal year ending June 30, 1891		5,167.93

(See Appendix P 5.)

6. *Pease River, Florida.*—This river rises about the center of Polk County, Florida, and flows southwest into Charlotte Harbor. For the last 10 miles of its course it has the characteristics of an estuary. The rest of the stream flows through a heavily wooded and sparsely populated country, and is much obstructed by fallen trees, snags, rocks, and bars. It is subject to great changes of level. During the low-water season not more than 14 inches to 24 inches of water can be relied on. Vessels drawing 10 feet of water can enter the mouth. Five feet can be carried to Cleveland, 7 miles from the mouth.

The project for its improvement, adopted in 1881, is to improve it for high-water navigation by the removal from the channel of snags, overhanging trees, and loose rocks between Fort Meade and the mouth, a distance by river of about 100 miles.

Up to June 30, 1889, $12,969.75 have been expended on this river. The only practical benefit from this expenditure is in a survey and map of the river. Snagging operations have been discontinued for several years owing to a lack of funds, and the channel opened has become entirely choked. Navigation of the upper river is now practically impossible. Owing to a lack of funds there were no operations during the past fiscal year.

The commercial importance of the river has been greatly increased by the discovery of large beds of phosphate along the stream which are now being mined. Shipments are now made by rail to Punta Gorda and thence by steamer.

July 1, 1889, amount available		$30.25
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$11.75	
July 1, 1890, outstanding liabilities	18.50	
		30.25
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		25,000.00

(See Appendix P 6.)

7. *Manatee River, Florida.*—The portion of the Manatee River under improvement is the lowest reach, between Rocky Bluff and the mouth, a distance of about 12 miles. This has a mid-channel depth of from 7 to 20 feet. The general width is about three-fourths of a mile. At the mouth is a long shoal with a minimum depth of 8½ feet. Between Pal-

metto and Manatee, about 6 miles from the mouth, is another bar covered by from 3 to 5 feet of water.

The river was examined in 1881. The project adopted had for its object to form a channel 100 feet wide and 13 feet deep at mean low water from Tampa Bay to McNeil's Point (Palma Sola). Owing to the changed commercial conditions since the adoption of the project brought about by the extension of the railroad to Tampa the transfer to Tampa of the principal gulf steam-ship lines, and the service of the smaller towns around Tampa Bay by coasting steamers from Tampa, the project was modified in 1886 to provide for the passage of these lighter-draught vessels to all of the towns of the lower river by the removal of the bar above Palmetto.

Up to the close of the fiscal year ending June 30, 1889, $22,684 had been expended, of which $12,000 had been used in 1883–'84 under the original project in making a cut 12½ feet deep across the bar at the mouth, and the remainder in 1887–'88 in a survey of the river as far as the head of navigation at Mitchellville, 12 miles above Rocky Bluff, the head of the lower river, and 24 miles from the mouth, and in dredging a channel 8 feet deep through the bulkhead between Palmetto and Manatee. At that date the dredged cut at the mouth had become obliterated by the action of the tidal currents of Tampa Bay which sweep directly across it. The cut between Manatee and Palmetto had shoaled but very slightly.

In October, November, and December, 1889, the cut between Palmetto and Braidentown was widened 40 feet and the shoals which had formed in the original cut removed. When work was completed the channel at the cut was 105 feet wide at its narrowest point and between 8 and 9 feet deep. In the remaining portions of the river the conditions were unchanged.

July 1, 1889, amount available		$816.21
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$602.68	
July 1, 1890, outstanding liabilities	21.66	
		624.34
July 1, 1890, balance available		191.87
Amount appropriated by act of September 19, 1890		6,000.00
Amount available for fiscal year ending June 30, 1891		6,191.87
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		39,000.00

(See Appendix P 7.)

8. *Tampa Bay, Florida.*—The harbor at Tampa, at the head of one arm of this bay, was separated from deep water by a flat 2 miles wide. Through this was a narrow channel with an average available depth of about 5 feet, formed by the waters of Hillsborough River.

The original project was adopted in 1879, and has for its object the formation of a 9-foot channel from the 9 foot curve in the bay to the wharves at Tampa, in Hillsborough River, 150 feet wide in the bay and 200 feet wide in the river, at an estimated cost of $97,000.

Up to June 30, 1888, $69,068.54 had been expended. The work consisted entirely of dredging and rock excavation, and extended over a distance of 8,200 feet, making a cut varying in width from 200 feet in the river to 60 feet in the bay. On June 30, 1887, it had a depth along its center line of from 8.3 to 9 feet. The depth on the flats beyond the outer extremity of the cut is 7 feet. In 1888 the project was modified.

Port Tampa, 9½ miles from Tampa on Old Tampa Bay had become the deep-water port of Tampa. The modified project is to form and maintain a channel 8 feet deep in Hillsborough Bay and Hillsborough River to the city of Tampa, and a channel 20 feet deep and 200 feet wide from the outer bar to Port Tampa. In the act of August 11, 1888, $25,000 was appropriated for work under this project. Owing to various unavoidable delays the contract for the work was not made until March 29, 1889. Work was begun June 29. The plant proved inadequate and it was removed. The time for the completion of the work was then extended until May 5, 1890. Work was recommenced early in February, but the plant was badly out of repair and on May 5 only 14,688 cubic yards had been removed out of the total estimated volume of 72,000 cubic yards. The contract has not yet been annulled and the contractor promises to recommence work at or before the end of July, 1890, with a new and powerful plant.

July 1, 1889, amount available		$2,272.97
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$1,235.80	
July 1, 1890, outstanding liabilities	10.10	
		1,245.90
July 1, 1890, balance available		1,027.07
Amount appropriated by act of September 19, 1890		25,000.00
Amount available for fiscal year ending June 30, 1891		26,027.07
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		10,000.00

(See Appendix P 8.)

9. *Withlacoochee River, Florida.*—This river is 120 miles long and has a normal width varying from 75 to 180 feet, though at numerous points a defined channel is almost lost in broad marshy lakes and cypress swamps. The low-water depth varied from 1 to 7½ feet. Before improvement the river was so obstructed by loose rocks, snags, fallen trees, floating grass islands, and bars as to be practically impassable excepting in isolated reaches.

The river was examined with a view to its improvement in 1879. The approved project calls for the removal of snags, overhanging trees, loose rocks, and some of the worst shoals between the Gulf of Mexico and Pemberton Ferry, a distance of about 77 miles, so as to permit boats of 2-feet draught to navigate the river during one-half the year.

Up to June 30, 1889, $14,342.90 had been expended. The river had been cleared and made navigable between Cotton's Grove and Pemberton Ferry, a distance of 38 miles. Three lines of small steamers plied on this reach, between the river landings and the railroads at Panasoffkee and Pemberton Ferry. During the past fiscal year $2,427.31 have been expended, mainly between Morrison's Landing and the Silver Spring, Ocala and Gulf Railroad Crossing at Dunellon, and a navigable channel has been opened between these points.

July 1, 1889, amount available	$4,157.10
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	2,427.31
July 1, 1890, balance available	1,729.79
Amount appropriated by act of September 19, 1890	5,400.00
Amount available for fiscal year ending June 30, 1891	7,129.79

(See Appendix P 9.)

10. *Harbor at Cedar Keys, Florida.*—The improvement of this harbor has been carried on from time to time, under various appropriations made since 1872. It was obstructed by a shoal locally called Bulkhead or Middle Ground, lying between Way Key and the main ship channel; at several points in the main ship-channel the rock, which everywhere underlies the harbor at a slight depth, by its outcropping, has decreased the general 12 foot depth of the channels to from 7 to 9 feet. The present project for the improvement of the harbor was adopted in 1883, and contemplates the formation of a channel 200 feet wide and 10½ feet deep through the shoals. An appropriation of $5,000 was made in 1884 for work under this project. With this a cut was made partially across one of these shoals. This cut has remained clear.

In the act approved August 5, 1886, $7,000 was appropriated for continuing this improvement. This amount was applied to re opening a cut through the Middle Ground, and changing its direction so as to insure greater permanence. The cut made in June, 1889, was 70 feet wide and 10½ feet deep. The last examination made showed that the cut had been well maintained by the tidal currents, but that it was too narrow for permanence. Twelve thousand two hundred and seventy-three dollars and thirty-six cents had been expended on this project up to June 30, 1889. Operations during the past fiscal year were limited to widening the Middle Ground Cut, with the appropriation made in the act of 1888. The work was done under contract and was unfinished at the close of the fiscal year.

The officer in charge reports that the commercial importance of this port has declined greatly and that in his judgment the existing facilities are sufficient for the present needs of commerce.

July 1, 1889, amount available		$726.64
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$308.90	
July 1, 1890, outstanding liabilities	189.70	
		498.60
July 1, 1890, balance available		228.04
Amount appropriated by act of September 19, 1890		2,500.00
Amount available for fiscal year ending June 30, 1891		2,728.04
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		44,000.00

(See Appendix P 10.)

11. *Suwanee River, Florida.*—The length of river under improvement is 130 miles. From the Derrick Gap entrance to Branford, a distance of 80 miles, the width of the river varies from 250 to 300 feet, and its original low-water depth from 3 to 30 feet. It was but little obstructed excepting at the mouth. Between Branford and Ellaville the general width is 325 feet. It was obstructed by many dangerous rock shoals crossed by crooked channels which had a low-water depth of from 1.5 to 3 feet.

A project for this improvement was adopted in 1880. It contemplates the formation of a channel 150 feet wide and 5 feet deep from the Gulf (through the bars at the passes) as far up the river as New Branford (Roland's Bluff). From there to Ellaville the channel is to be 60 feet wide and 4 feet deep.

Up to the close of the fiscal year ending June 30, 1889, $25,791.12 had been expended. A cut 6,000 feet long, 60 feet wide, and 5 feet deep at mean low water had been made across the shoals at the mouth; a

large number of snags and overhanging trees had been cut and removed and channels had been blasted through some of the worst shoals. A portion of this work was done by the steam snag-boat built early in 1889. Navigation was made safe from Cedar Keys to Branford. During the past fiscal year the operations of the snag-boat were entirely between Branford and Ellaville. Six hundred and eleven cubic yards of rock were removed from the shoals by blasting and dredging, and a large amount of sunken and overhanging timber was cleared away. The river is now navigable as far as Hudson, 12 miles by rail below Ellaville, but at extreme low water navigation is still too dangerous for boats to make regular trips.

July 1, 1889, amount available		$2,208.88
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$1,545.75	
July 1, 1890, outstanding liabilities	23.30	
		1,569.05
July 1, 1890, balance available		639.83
Amount appropriated by act of September 19, 1890		3,000.00
Amount available for fiscal year ending June 30, 1891		3,639.83
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		24,158,00

(See Appendix P 11.)

12. *Removing sunken vessels or craft obstructing or endangering navigation.*—The remainder of the wreck, supposed to be that of the German brig *Neva*, was removed by the contractor from Ward's Bank at the mouth of St. John's River. About 36 cords of its cargo of logwood were recovered.

Obstructions having been reported again at the site of the wreck of the steamer *Maple Leaf*, the wreck and vicinity were carefully examined. An old pile, supposed to be from a former beacon, an iron pipe, and what seemed a piece of the deck-house frame were discovered extending above the plane 18 feet below mean low water, to which the wreck had been removed. All were removed.

(See Appendix P 12.)

EXAMINATION AND SURVEY FOR IMPROVEMENT, TO COMPLY WITH REQUIREMENTS OF RIVER AND HARBOR ACT OF AUGUST 11, 1888.

It appearing from the preliminary examination made by the local engineer that Sarasota Bay, Florida, is worthy of improvement, and the public necessity therefor being apparent from the facts and reasons reported, which are concurred in by the Chief of Engineers, Captain Black was charged with and completed its survey, the results of which were transmitted to Congress, and printed as House Ex. Doc. 61, Fifty-first Congress, first session. (See also Appendix P 13.)

IMPROVEMENT OF CERTAIN RIVERS IN THE STATES OF FLORIDA, GEORGIA, AND ALABAMA, OF APALACHICOLA BAY, AND OF HARBOR AT PENSACOLA, FLORIDA.

Officer in charge, Capt. P. M. Price, Corps of Engineers, having under his immediate orders, since October 14, 1889, Second Lieut. C. L. Potter, Corps of Engineers; Division Engineer, Col. C. B. Comstock, Corps of Engineers.

1. *Apalachicola River, Florida.*—An examination and survey of this

river was made in the winter of 1872–'73. The river was found to be obstructed by snags and overhanging trees. An accumulation of drift-logs against piles, driven by Confederate authorities during the war, near Moccasin Slough had formed a dam across the river and forced a narrow and very crooked channel through its banks into the River Styx.

The approved project for the improvement of the river contemplated securing a channel 100 feet wide and 6 feet deep at low water, by the removal of snags and overhanging trees, and widening and straightening the channel at Moccasin Slough, at an estimated cost of $80,333.

Forty thousand seven hundred and forty-five dollars and fifty-nine cents were expended on this project up to the close of the fiscal year ending June 30, 1889. At this date the river was in a good navigable condition, except at Moccasin Slough and the Upper and Lower Elbows, where further work is necessary to make navigation safe, and it is estimated that this work can be done for $5,000. To preserve the improvement already made an annual sum of $2,000 is required for the removal of the accumulation of snags and overhanging trees.

During the year ending June 30, 1890, the sum of $1,437.62 has been expended in the removal of snags, sunken logs, and overhanging trees.

It is proposed to use the balance available for the maintenance of the existing improvement.

July 1, 1889, amount available	$1,758.41
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,437.62
July 1, 1890, balance available	320.79
Amount appropriated by act of September 19, 1890	2,000.00
Amount available for fiscal year ending June 30, 1891	2,320.79

(See Appendix Q 1.)

2. *Apalachicola Bay, Florida.*—A bar existed at the mouth of the Apalachicola River, extending from one-half mile below the town of Apalachicola, Fla., to the Lower Anchorage. The minimum channel depth over this bar was 3½ feet.

In 1879 a plan of improvement was adopted which contemplated the dredging through the bar of a straight channel 11 feet deep and 100 feet wide, to be afterwards increased to 200 feet if the first cut should produce results that would warrant it.

Up to June 30, 1889, the sum of $67,324.73 had been expended on this improvement in doing more or less annual dredging during the years 1881 to 1885, and in 1887. On account of inadequate appropriations, the dredged cut has never exceeded 75 feet in width and 9½ feet in depth, and has gradually filled up, partly by the deposit of silt from the river, and partly by the washing in of material from the sides of the cut by the currents, caused by the tides and the prevailing easterly winds. On June 30, 1889, the channel had shoaled to a least depth of 4 feet at mean low water.

During the year ending June 30, 1890, $17,684.90 have been expended. On June 12, 1889, a contract with the Alabama Dredging and Jetty Company, of Mobile, Ala., was approved, for re-dredging the channel through the bar to a depth of 8 feet, and to as great a width—not exceeding 100 feet—as the funds available ($19,671.77) would permit of. For various reasons the time for beginning work under this contract was extended to November 15, 1889, and the time of completing the contract to May 15, 1890. Under this contract 65,547 cubic yards of

mud and sand were removed from the channel. The cut began 750 feet south of the outer beacon, and ended at a point 250 feet north of the inner beacon, a total length of 6,000 feet, with a width varying from 80 to 90 feet, and a depth of 8 feet. The work has been a great relief to the commerce of Apalachicola.

July 1, 1889, amount available		$19,675.52
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$17,684.90	
July 1, 1890, outstanding liabilities	401.50	
		18,086.40
July 1, 1890, balance available		1,589.12
Amount appropriated by act of September 19, 1890		20,000.00
Amount available for fiscal year ending June 30, 1891		21,589.12
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		40,000.00

(See Appendix Q 2.)

3. *La Grange Bayou, Florida.*—The plan of improvement adopted was made pursuant to an examination of this bayou in 1881, under an act of Congress approved March 3, 1881, and contemplates the deepening of the channel through the bayou, so as to admit of the passage of vessels drawing 4½ feet at mean low water, the work to be done by dredging.

Up to June 30, 1888, there had been expended on this work the sum of $2,000, allotted from the appropriation of $20,000, made by an act approved August 2, 1882, for the improvement of the Choctawhatchee River, Florida. The result was the securing of a channel 5 feet in depth at mean low water.

The act of August 5, 1886, appropriated $2,000 for this improvement. It was decided that this appropriation could be more profitably expended by holding it until an additional appropriation was made. The act of August 11, 1888, appropriated $3,000 for completing the improvement of La Grange Bayou, including Holmes River up to the town of Vernon. An examination and partial survey made in February, 1889, showed that the completion of the improvement at La Grange Bayou would cost about $12,000, and that the removal of the snags, logs and overhanging trees from Holmes River would cost about $3,000, exclusive of the cost of the necessary plant. These facts being submitted to the Secretary of War, he directed that no further expenditure should be made from these appropriations. Holmes River can be most economically cleared of obstructions by employing the plant, with certain modifications, now provided for the Choctawhatchee River, using it during the high-water stages of the latter river, when it would otherwise be laid up. Should it be decided to improve Holmes River, it is recommended that the appropriation be made for that purpose only, and that its improvement be disassociated from that of La Grange Bayou, Florida, with which it has no connection whatever. Holmes River is an affluent of the Choctawhatchee River. The distance from its mouth to Vernon is estimated at 28 miles.

July 1, 1889, amount available	$4,839.20
July 1, 1890, balance available	4,839.20
Amount appropriated by act of September 19, 1890	3,000.00
Amount available for fiscal year ending June 30, 1891	7,839.20

(See Appendix Q 3.)

4. *Harbor at Pensacola, Florida.*—In 1878 the channel was much obstructed by wrecks, and a survey made in 1879 showed that the inner bar had shoaled to a depth of 19 feet at mean low water. This depth was not sufficent to accommodate a large number of vessels seeking entrance to the port. The western shore of the entrance to the harbor, which is the site of old Fort McRee, was fast washing away, and a large portion of the fort had disappeared. Corresponding changes in the directions of the channel and of the tidal currents had occurred, and to these was attributed the shoaling of the inner bar. The removal of the wrecks was begun in 1878.

The plan of improvement adopted in 1881, contemplates dredging a channel 300 feet wide and 24 feet deep at mean low water across the inner bar, for temporary relief of the navigation of this harbor, and protecting the shore-line near Fort McRee from further abrasion, by the construction of jetties and works of shore protection, with a view to retaining this position for defensive purposes, and preventing further injurious changes in the tidal currents.

The expenditure up to June 30, 1889, of $223,352.79 had resulted in obtaining temporarily, a channel across the inner bar, reported to be 120 feet wide and 24 feet deep, at mean low water, at the conclusion of dredging operations in 1886. Since then no dredging has been done and the channel has gradually shoaled until it had a least depth of 19.6 feet at mean low water in April, 1890.

Between 1881 and 1887, the further abrasion of the western shore line, near Fort McRee, was stopped by the construction of two jetties, north of the fort, and nearly at right angles to the shore, having lengths, respectively, of 360 and 220 feet. The jetties were originally of a tentative character, and were built of two parallel rows of close piling, filled with alternate layers of brush and stone, with side slopes of similar construction. They were exposed to the attacks of the teredo, and to the destructive action of severe storms.

Previous to 1888, notwithstanding that much repair and auxiliary work had been done to preserve them, not more than 75 per cent. of the jetties remained. Their usefulness in preserving the shore line having been demonstrated, it was then decided to rebuild them in a substantial manner by covering them with a coping and side slopes of heavy stone and concrete blocks. Up to June 30, 1889, about 2,500 tons of stone—the larger pieces weighing from 1 to 4 tons—had been placed on the North Jetty, and a considerable number of concrete blocks, varying in weight from about 3 to 7 tons, had been molded, but not yet placed in the jetties.

During the year ending June 30, 1890, the expenditure of $18,492.10 has resulted in rebuilding the jetties, as far as now appears to be necessary in order to accomplish the purpose desired. In the core of the jetty the concrete blocks were carefully placed in regular order by a diver. In the side slopes the blocks are placed at random. The core of the jetty is surmounted above the plane of mean low water by a monolithic concrete coping. Since the completion of the work, in April, 1890, this coast has been visited by unusually heavy storms, which the reconstructed jetties have withstood perfectly. No settlement nor derangement has been noticed.

In April, 1890, a detailed survey of the entrance to the harbor, to include careful observations of the velocities and directions of the currents was begun, but has been much interrupted by unusually stormy weather.

The original project for the improvement of the harbor did not pro-

vide for dredging a channel through the outer bar to correspond with that through the inner bar. An examination made in April, 1890, showed a least depth of 19.6 feet on the inner bar, and 22.1 feet on the outer bar. As a result of this examination, it was estimated that the sum of $106,446, to be available in one sum, was required to dredge a channel 300 feet wide and 24 feet deep through both bars.

July 1, 1889, amount available		$26,647.21
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$18,492.10	
July 1, 1890, outstanding liabilities	1,147.49	
		19,639.59
July 1, 1890, balance available		7,007.62
Amount appropriated by act of September 19, 1890		25,000.00
Amount available for fiscal year ending June 30, 1891		32,007.62
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		81,446.00

(See Appendix Q 4.)

5. *Choctawhatchee River, Florida and Alabama.*—When work on the improvement was first commenced, in 1874, the river, although having an average width of 350 feet, was almost totally obstructed, admitting only narrow barges, and flats of light draught of water to be navigated, and the channel—if a channel existed at all—was such as to be extremely dangerous to navigation, particularly during the low water stages.

The present plan of improvement was adopted in 1872, and modified in 1880. It contemplates the improvement of the river to obtain a low water navigable channel from its mouth to Geneva, Ala., an estimated distance of 125 miles, and a navigable high-water channel from Geneva to Newton, Ala., an estimated distance of 37 miles.

The expenditure up to June 30, 1889, of $88,486.19, has resulted in giving a fairly navigable channel, except at extreme low water, from the crossing of the Pensacola and Atlantic Railroad, at Caryville, Fla., to Geneva, Ala., a distance of 25 miles, and a partially improved channel from Geneva to Pates Landing, a distance of about 25 miles.

Four steam-boats now run regularly between Geneva, Ala., and Caryville, Fla., and the population of the surrounding country is increasing rapidly. The river is the only outlet for their products.

During the year ending June 30, 1890, $7,640.04 have been expended. Of this amount, $4,800 was paid for a new snag-boat, to replace the old one, which had become totally useless. The channel between Geneva and a point 2½ miles above Pates Landing and between Geneva and Caryville, was cleared of such snags and logs as formed the worst obstructions.

July 1, 1889, amount available		$8,513.81
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$7,640.04	
July 1, 1890, outstanding liabilities	40.00	
		7,680.04
July 1, 1890, balance available		833.77
Amount appropriated by act of September 19, 1890		12,500.00
Amount available for fiscal year ending June 30, 1891		13,333.77

(See Appendix Q 5.)

6. *Escambia and Conecuh rivers, Florida and Alabama.*—The river originally was much obstructed by snags, sunken logs, and rock shoals, and by a very shoal bar at the mouth. Steam-boat navigation was not attempted, and rafts had much difficulty in passing down the river.

The plan of improvement for this river, adopted pursuant to examinations and surveys made in 1878 and 1879, contemplates the removal of snags, sunken logs, and other obstructions from the channel, cutting through rock shoals and deepening sand-bars by works of contraction and shore protection, from the mouth of the river in Pensacola Bay to the mouth of Indian Creek, an estimated distance of 293 miles, for the purpose of facilitating the movement of timber down the river, affording at the same time facilities for steam-boat navigation.

The amount expended up to June 30, 1889, $51,222.63, had resulted in dredging a channel through the bar at the mouth of the river—which, however, had again shoaled to such an extent as to require redredging—and in the removal of obstructions to navigation, so that at that time the river was navigable at ordinary stages for steam-boats drawing 5½ feet of water from Ferry Pass to Skinner's Landing, a distance of 17 miles; and for boats drawing 3 feet to the Alabama State line; and the river had been so far cleared of logs, snags, and overhanging trees that the lower 118 miles was in a good navigable condition for stages of water above the 2½-foot stage.

During the fiscal year ending June 30, 1890, $6,008.29 was expended upon this improvement, and has resulted in securing, by dredging, a good channel 60 feet in width and 6 feet in depth at low water, through the bar at the mouth of the river. Snags and overhanging trees have been removed from 28 miles of the river, and some work of removing rock and gravel from the bars has been done. The channel, from Thompson's Cut-off to the mouth of the river, a distance of 133 miles, is now in a fairly navigable condition for all stages higher than 2½ feet above low water.

July 1, 1889, amount available		$7,922.67
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$6,008.29	
July 1, 1890, outstanding liabilities	932.70	
		6,940.99
July 1, 1890, balance available		981.68
Amount appropriated by act of September 19, 1890		7,500.00
Amount available for fiscal year ending June 30, 1891		8,481.68
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		17,930.00

(See Appendix Q 6.)

7. *Flint River, Georgia.*—Before the improvement was begun the river was only navigable, at low water, from its mouth up to Bainbridge, and the channel over this portion was narrow, crooked, and much obstructed by logs, snags, and overhanging trees.

The present project for the improvement of this river was adopted in 1873, and modified in 1879, the object of the original project being to afford a channel 100 feet wide and 3 feet deep at low water, from its mouth up to Albany, Ga., an estimated distance of 105 miles; and, of the modification, to provide a navigable channel for light-draught steamers, at moderate stages of water, from Albany to Montezuma, an estimated distance of 77 miles.

The expenditure up to June 30, 1889, of $122,363.76, has resulted in

obtaining a navigable channel, having a low-water depth of 3 feet, and a width varying from 50 to 100 feet, from the mouth of the river nearly to Albany. Above Albany the river has been partially cleared of logs and snags, and, to a limited extent, of loose rock between Albany and Montezuma, and a small steam-boat now runs regularly on this portion of the river.

During the year ending June 30, 1890, $13,840.01 were expended, mainly on necessary plant, consisting of one snag-boat and one drilling-barge. The worst obstructions were removed from the channel over a distance of 56 miles, between Albany and Montezuma. The drilling-barge worked on the rock shoals near Albany from June until September 30, 1889, when work was stopped on account of the exhaustion of the appropriation.

July 1, 1889, amount available		$14,666.25
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$13,840.01	
July 1, 1890, outstanding liabilities	85.80	
		13,925.81
July 1, 1890, balance available		740.44
Amount appropriated by act of September 19, 1890		20,000.00
Amount available for fiscal year ending June 30, 1891		20,740.44
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		42,962.00

(See Appendix Q 7.)

8. *Coosa River, Georgia and Alabama.*—The river was originally much obstructed by rock-shoals and sand-bars between Rome, Ga., and Greensport, Ala., and below Greensport it was not navigable at all on account of the many shoals and rapids, formed by ledges of rock crossing the river bottom at points where the width of the river was greater than the normal. The normal width of the river at low water is from 500 to 800 feet. From Rome, Ga., to Greensport, Ala., an estimated distance of 162 miles, the river has an average slope of about 5 inches per mile, with banks which are firm and not easily eroded. From Greensport down to Wetumpka, Ala., an estimated distance of 142 miles, the profile of the natural river, at low water, exhibits a succession of deep pools, varying in length from one-half to 8 miles, separated by shoals formed of ledges of solid rock or loose stones and detached bowlders, which frequently rise above the surface. The shoals extend along the river for distances varying from a few feet to 12 miles and have depths of water varying from a few inches to several feet. Velocity observations at Wetumpka showed a low-water discharge of 5,796 cubic feet, about the same as that reported for the Mississippi River at St. Paul. The abundance of water, the stability of the banks and bottom of the river, and the rock foundations for locks and dams, presented in all cases, make the lower portion of the river peculiarly susceptible of permanent improvement by a system of slack-water navigation.

By means of the Upper Coosa, the Oostenaula, and Coosawattee rivers there is now a stretch of 293 miles of navigable river above Lock No. 4, and by means of the Coosa and Alabama rivers a stretch of 367 miles of easily navigable river below Wetumpka. The improvement of the 116 miles of river between Lock No. 4 and Wetumpka will therefore afford a continuous route of water transportation, 776 miles in length from northwestern Georgia, through the mineral region of north Alabama to the Gulf of Mexico at Mobile, Ala.

Pursuant to various examinations and surveys made between 1870 and 1878 a plan of improvement was originally adopted which contemplated the removal of the lesser rock shoals and sand and gravel bars by excavation and by works of contraction, so as to give a minimum depth of 3 feet at low water in the channel and the construction of locks and dams to overcome the more serious obstructions below Greensport. The project as approved was limited to the section of river between Rome, Ga., and the East Tennessee, Virginia and Georgia Railroad Bridge, an estimated distance of 236 miles.

Under the act of August 11, 1888, a survey was made between May and November, 1889, from the rapids at Wetumpka to connect with the improvements already completed below Greensport. The report of this survey, submitting a plan and estimates for the improvement of this portion of the river, was printed as House Ex. Doc. No. 94, Fifty-first Congress, first session.

The expenditure up to June 30, 1889, of $487,995.34 had resulted in securing a fairly navigable channel from Rome, Ga., to Greensport, Ala., by blasting out the rock shoals, and by the construction of wing-dams to scour out the sand-bars. Three masonry locks, each 40 feet wide by 210 feet between mitre sills, at distances respectively of 0.68, 3.86, and 5.24 miles below Greensport, had been nearly completed, with their accessory dams and dikes, and preparations had been made for the commencement of a fourth lock and dam 21 miles below Lock No. 3.

During the year ending June 30, 1890, the expenditure of $31,675.97 has resulted in the completion of Locks Nos. 1, 2, and 3, and in equipping them with all the machinery needed for their operation, and in the required improvement of the channel between Locks Nos. 1 and 2, and Locks Nos. 2 and 3.

For the efficient operation of the locks, dwellings for the lock-keepers are needed at each lock. Crib-work guiding-piers are also needed at the head and foot of each lock to make easy ingress and egress. As soon as the dam at Lock No. 4 is finished, the upper river boats by passing through Locks Nos. 1, 2, and 3 will be able to reach the extensive Broken Arrow coal-fields, which are situated between Locks Nos. 3 and 4.

As stated in last annual report—for fiscal year ending June 30, 1889—it is proposed to increase the dimensions of Lock No. 4, and those below it, to 52 by 322 feet, in order to furnish the down-stream coal and iron-ore traffic with facilities for the passage of one tow-boat and three barges through each lock at one lockage.

In view of the fact that a re-survey was then being made of the portion of the river below Lock No. 4 on which to base revised estimates for its improvement, the amount estimated for the completion of the existing project in the annual report for the fiscal year ending June 30, 1889, provided only for the completion of the work from Rome, Ga., to and including Lock No. 4, Alabama, 3 miles above the crossing of the Georgia Pacific Railroad.

The estimate herewith submitted for the completion of the existing project provides for the completion of the channel work between Rome, Ga., and Lock No. 4; for the building of the necessary crib-work guiding piers, for the grading and protection of the grounds and banks adjacent to the locks, and for the building of lock-keepers' dwellings at Locks Nos. 1, 2, 3, and 4; for the completion of the dam and construction of Lock No. 4; and for the completion of the channel work and construction of the 4 locks and dams, required between Lock No. 4 and

the East Tennessee, Virginia and Georgia Railroad Bridge, as estimated in the report mentioned above.

July 1, 1889, amount available		$35,704.66
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$31,675.97	
July 1, 1890, outstanding liabilities	3,326.05	
		35,002.02
July 1, 1890, balance available		702.64
Amount appropriated by act of September 19, 1890		300,000.00
Amount available for fiscal year ending June 30, 1891		300,702.64
Amount (estimated) required for completion of existing project between Rome, Ga., and East Tennessee, Virginia and Georgia Railroad Bridge Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		971,840.00

(See Appendix Q 8.)

9. *Chattahoochee River, Georgia and Alabama.*—The river was originally much obstructed by logs, snags, and overhanging trees and by a number of rock and marl shoals and sand-bars, so that navigation was difficult and dangerous. Steam-boats could only run by daylight, and not unfrequently laid on sand-bars for weeks at a time waiting for a rise in the river. Very many were lost by striking logs or snags.

The present plan of improvement adopted in 1873 and modified in 1882, contemplates a low-water channel 4 feet in depth and 100 feet in width from Columbus, Ga., to Chattahoochee, Fla., a distance of 224 miles, by the removal of snags and other obstructions from the channel and overhanging trees from the banks; by the excavation of rock shoals, and by works of contraction and shore protection.

Previous to the act of June 18, 1878, $70,000 were appropriated for the "Chattahoochee and Flint rivers," but the amounts apportioned to each river are not known.

Up to June 30, 1889, $230,641.61 of the appropriations for the Chattahoochee River alone had been expended, and with its share of the combined appropriations had resulted in securing a fair navigable channel between Chattahoochee, Fla., and Eufaula, Ala., at all seasons of the year, and between Eufaula, Ala., and Columbus, Ga., at all times, except during the prevalence of extreme low water. Steam-boats now make regular trips with but few accidents or detentions, running by night as well as by day. The limited annual appropriations for this improvement have not been sufficient to maintain the works of contraction constructed, nor to extend or modify them as required.

During the year ending June 30, 1890, $10,191.30 have been expended in maintaining the existing improvement, excavating rock-shoals, and in procuring new plant to replace that worn out.

July 1, 1889, amount available		$12,376.60
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$10,191.30	
July 1, 1890, outstanding liabilities	569.72	
		10,761.02
July 1, 1890, balance available		1,615.58
Amount appropriated by act of September 19, 1890		20,000.00
Amount available for fiscal year ending June 30, 1891		21,615.58
Amount (estimated) required for completion of existing project Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		192,247.00

(See Appendix Q 9.)

10. *Tallapoosa River, Alabama.*—The condition of the river when first examined, in 1881, was such that at low water navigation was entirely impracticable on account of the numerous sand and gravel bars, and reefs of rock across the river, and the great accumulation of logs and snags in the channel, and the latter also rendered high-water navigation extremely difficult and dangerous. But for these obstructions the river presented, generally, long reaches of fine navigable water, with a width of 200 to 300 feet, and a depth of 6 to 12 feet, but where this width was exceeded to any extent gravel and sand bars were found, with a low-water depth of only 1 to 2 feet.

The original project, adopted pursuant to an examination and partial survey made in 1881, provided for obtaining a navigable channel from the junction with the Coosa River, where the two rivers form the Alabama River, to the foot of Tallassee Reefs, 2 miles below the town of Tallassee, a distance of 48 miles, with a least depth of 3 feet and width of 200 feet in open river, and 60 feet through the soft rock-reefs, by the removal of snags and logs from the channel, and overhanging trees from the banks; by cutting through the gravel and rock-reefs, and by deepening the sand-bars by works of contraction and shore protection.

The expenditure of $35,837.34 up to June 30, 1889, had resulted in providing a suitable snag-boat; in removing snags and logs obstructing the channel; in cutting down dangerous overhanging timber, and building 320 feet of temporary jetty, and in re-working, each year, the part passed over during the previous season to remove snags and logs brought down by freshets; and that portion of the river under improvement is now navigable at moderate stages of water.

During the fiscal year ending June 30, 1890, $3,829.24 was expended in maintaining the existing improvement.

The original estimate of the cost of the improvement was $40,125, but this contemplated continuous and expeditious work, with sufficient appropriations. These, however, have not been provided, and the greater part of the money heretofore appropriated has been expended in the removal of the annual accumulation of logs and snags, and but a small amount has been available for the more permanent work contemplated by the project. On account of changes which have since occurred the survey of 1881 does not now furnish the data necessary for estimating the amount required to complete the existing project.

July 1, 1889, amount available		$4,180.66
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$3,829.24	
July 1, 1890, outstanding liabilities	184.72	
		4,013.96
July 1, 1890, balance available		166.70
Amount appropriated by act of September 19, 1890		4,000.00
Amount available for fiscal year ending June 30, 1891		4,166.70

(See Appendix Q 10.)

11. *Cahaba River, Alabama.*—The report of the examination of this river, from its mouth to Centerville, Ala., in 1874, states that "on thirteen of the shoals there is only 1 foot of water, and on two as little as eight-tenths of a foot. Besides this there are innumerable snags, the accumulation of years, and also a great quantity of leaning trees, which must be removed owing to the narrowness of the stream even at a stage several feet above low water. * * * The river is spanned by three bridges. * * * The railroad bridges are only a few inches above high water, while the road bridge is sometimes submerged." * * *

The road bridge mentioned was carried away by the flood of 1881.

Under acts of Congress approved June 23, 1874, and June 17, 1880, examinations and partial surveys were made in 1874 and in 1880, and a plan of improvement was adopted which provides for obtaining for the lower Cahaba River, from its mouth to the town of Centerville, a distance of 88 miles, a navigable channel with a width in open river of 100 feet, and in soft rock and bar cuts of 60 feet, having a depth at low water of 3 feet, by the removal of snags, etc., from the channel and overhanging trees from the banks; by cutting through the soft rock and gravel bars, and by contracting and regulating the channel.

The expenditure up to June 30, 1886, of $28,989.79 had resulted in the partial improvement of the river from its mouth to Centerville, adapting it to high-water navigation, but on account of the obstructing railroad bridges, steam-boats were unable to make any use of the improved river. Since that time no work has been done because of a proviso in the river and harbor act of August 5, 1886, that "no part of said sum ($7,500 appropriated for this work) shall be expended until the officer in charge shall have reported that the railroad and other bridges across said river have been provided with good and sufficient draw openings." These bridges continue to obstruct the navigation of the river, not having been provided with draw openings. The working plant of the Cahaba River has been transferred to the Escambia and Conecuh Improvement.

During the year ending June 30, 1890, $13.50 was expended to defray the costs of an examination of the bridges obstructing the navigation of this river, made in compliance with a request of Hon. J. E. Cobb, M. C., dated March 25, 1890.

This examination showed that no changes had been made in the railroad bridges, but no action was taken in the matter on account of the withdrawal of his complaint by the Honorable Mr. Cobb, under date of April 24, 1890.

July 1, 1889, amount available	$7,801.85
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	31.50
July 1, 1890, balance available	7,770.35
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	157,500.00

(See Appendix Q 11.)

12. *Alabama River, Alabama.*—Before improvements were begun in 1878, the river was so full of sunken logs and snags, and so obstructed by bars, shoals, and reefs—on many of which the low-water depth was only 2½ to 3½ feet—that navigation was both difficult and dangerous, and many boats were destroyed. At low water stages boats could only run by day-light, and long detentions at the bars and shoals were frequent. The normal width of the upper river is from 500 to 600 feet, and of the lower river from 700 to 800 feet. In the portions of the river having these widths, the low-water depths vary from 8 to 15 feet; but where the river has been widened by the erosion of its banks, bars, shoals, and reefs are found. That portion below the Cut-off—20 miles in length—was absolutely inaccessible during low water, and all landings situated thereupon were deprived of steam-boat service during that season.

The plan of improvement adopted pursuant to an examination and partial survey of this river made under act of Congress, approved March

3, 1875, provides for obtaining a channel 200 feet in width, and 4 feet in depth, at low water, from the mouth of the river, 44 miles above Mobile, to Wetumpka, Ala., a distance of 323 miles, by the removal of snags, logs, etc., from the channel; cutting overhanging trees from the banks; removing rock and gravel reefs by blasting and dredging; and deepening sand-bars by works of contraction and shore protection.

The expenditure of $151,595.08, up to June 30, 1889, had resulted in clearing the river of dangerous snags and overhanging timber; in the improvement of the worst bars; in opening the 20 miles of the river below the Cut-off; in an increased safety to navigation; greater regularity and reduction in time of trips, and enabling boats to carry larger loads. Boats now run by night, as well as by day, at all stages of water.

The original estimate, in 1876, of the cost of the improvement of this river, was $229,741. This estimate contemplated that the project should be prosecuted continuously and expeditiously by the appropriation of the amounts annually recommended. Such appropriations have not, however, been made, and no appropriations, whatever, were made in the years 1883, 1885, 1887, and 1889. The work has, so far, extended over a period of 12 years, with total appropriations amounting to $185,000, of which, much the larger part has been necessarily expended in removing the annual accumulation of logs and snags, due to freshets, and in maintaining the improvement accomplished with the earlier appropriations. The survey of 1875 does not now furnish data for estimating the amount required to complete the original project.

During the year ending June 30, 1890, $8,806.97 were expended in maintaining the existing improvement.

July 1, 1889, amount available		$13,404.92
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$8,806.97	
July 1, 1890, outstanding liabilities	2,290.21	
		11,097.18
July 1, 1890, balance available		2,307.74
Amount appropriated by act of September 19, 1890		20,000.00
Amount available for fiscal year ending June 30, 1891		22,307.74

(See Appendix Q 12.)

13. *Operating and care of canals and other works of navigation on the Coosa River, Georgia and Alabama.*—The expenses of operating Lock No. 1 since March 1, 1890, of operating Lock No. 2 since March 16, 1890, and of operating Lock No. 3 since May 27, 1890, have been paid in the manner indicated by section 4, act of July 5, 1884.

The amount expended during the fiscal year ending June 30, 1890, was $326.42.

(See Appendix Q 13.)

EXAMINATION AND SURVEY FOR IMPROVEMENT, TO COMPLY WITH REQUIREMENTS OF RIVER AND HARBOR ACT OF AUGUST 11, 1888.

It appearing from the preliminary examination made by the local engineer of *Coosa River, Alabama, from the rapids at Wetumka, to connect with the improvements already completed on said river above the Ten Islands*, that the locality is worthy of improvement, and the public necessity therefor being apparent from the facts and reasons reported, which are concurred in by the Chief of Engineers, Captain Price was charged with and completed its survey, the results of which were transmitted to Congress and printed as House Ex. Doc. 94, Fifty-first Congress, first session. (See also Appendix Q 14.)

IMPROVEMENT OF THE HARBOR OF MOBILE, OF WARRIOR, TOMBIGBEE, AND BLACK WARRIOR RIVERS, ALABAMA, AND OF CERTAIN RIVERS IN MISSISSIPPI—IMPROVEMENT OF CHANNEL TO BILOXI BAY.

Officer in charge, Maj. A. N. Damrell, Corps of Engineers; Division Engineer, Col. C. B. Comstock, Corps of Engineers.

1. *Mobile Harbor, Alabama.*—The present project for the improvement of this harbor was adopted in August, 1888, the object being to afford a channel of entrance from the Gulf of Mexico to the city of Mobile of 280 feet width on top of cut, with a central depth of 23 feet at mean low water, by dredging at an estimated cost of $1,980,000.

The channel had originally a minimum depth of 5½ feet through Choctaw Pass and 8 feet on Dog River Bar. This was deepened by dredging, under appropriations from 1826 to 1852 of $228,830.68, to 10 feet through both.

In 1860 the channel in Choctaw Pass had shoaled to 7½ feet.

From 1870 to 1878 the channel was deepened by dredging to 13 feet, under appropriations amounting to $401,000. Length of cut, 8 miles. From 1881 to 1888 the channel was deepened by dredging to 17 feet, under appropriations amounting to $740,000, but this project was not completed when the last project was adopted. The length of the cut was 25.91 miles.

Since the adoption of the last or present project a channel has been dredged to a depth of 19 feet and width of 80 feet, from where there was that depth in Mobile River to where the same depth was found in the lower part of the bay, a continuous cut of over 26 miles, about one-half was done in the fiscal year 1888-1889, and the remainder during the last fiscal year.

The lower portion has shoaled so that the least depth is now 15.6.

The average central depth is, however, about 18½ feet for the whole length of the channel.

The amount available is to be applied to continuing the improvement in accordance with the approved project.

July 1, 1889, amount available	$4,476.03
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,967.78
July 1, 1890, balance available	2,508.25
Amount appropriated by act of September 19, 1890	350,000.00
Amount available for fiscal year ending June 30, 1891	352,508.25
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	1,380,000.00

(See Appendix R 1.)

2. *Black Warrior River, Alabama, from Tuscaloosa to Daniels Creek.*—The present project for the improvement of this section of the river was adopted in 1886, the object being to afford a water-way for the transportation of coal, iron ore, iron, etc., in barges from the Warrior coal fields to the Gulf of Mexico, by the construction of five locks and dams, at an estimated cost of $741,670.

The present channel is only navigable during very high water, and is even then extremely dangerous. The amount expended to June 30, 1889, was $134,121.03. This was used in necessary surveys, preparation of plans and estimates; acquisition of land for site for Lock No. 1; erection of lock-tender's house and buildings required for quarters, kitchen, store-rooms, tool-rooms, cement-warehouses, blacksmith-shop,

and shed, and construction of two boats; clearing of lock-site; excavation of foundation pit for bank wall; stripping of quarry; grading of track from lock to quarry; construction of coffer-dam; laying track from the lock to the quarry 1¾ miles; making two inclines from the bank into the lock-chamber; framing and setting up nineteen derricks; construction of boat for derrick and two barges; quarrying of 7,811 cubic yards of stone; cutting of 2,364 cubic yards of stone; laying of 1,434 cubic yards of masonry; excavation of 816 cubic yards of rock and 1,500 cubic yards of earth in foundation.

The amount expended during the fiscal year ending June 30, 1890, is $54,044.41, and resulted in the completion of the river-wall of Lock No. 1, except the placing of six (6) pieces of coping, the construction of the bank-wall to a height of 24 feet (6 feet below top), construction of breast-wall for needle dam and trestles, construction of more than half of the lift-wall, completion of excavation of lock-chamber except 1,000 yards, and commencement of base of dam.

July 1, 1889, amount available		$62,244.96
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$54,044.41	
July 1, 1890, outstanding liabilities	3,343.12	
		57,387.53
July 1, 1890, balance available		4,857.43
Amount appropriated by act of September 19, 1890		150,000.00
Amount available for fiscal year ending June 30, 1891		154,857.43
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		385,420.00

(See Appendix R 2.)

3. *Warrior and Tombigbee Rivers, Alabama and Mississippi.*—(*a*) *Warrior River, Alabama.*—The present project for the improvement of this river was adopted in 1875, the object being to obtain a channel 4 feet deep at ordinary low water, and 80 feet wide from Tuscaloosa to its mouth by the removal of logs, snags, and overhanging trees, and the improvement of bars by jetties, at an estimated cost of $151,103. The channel at that time was not navigable at a low-water stage. The amount expended to June 30, 1889, was about $116,709.33 (exact figures can not be given, as for the years 1875 to 1882, inclusive, the appropriation was made for the Tombigbee and Warriors rivers jointly, without any special allotment for each, and therefore no separate account was kept), and resulted in obtaining a channel safely and easily navigable at a stage of water fully 3 feet lower than was formerly practicable. The amount expended during the fiscal year ending June 30, 1890, was $3,710.65, and was used in the removal of an accumulation of logs and drift that had formed at Forest Piers and in construction of a portion of the plant required for future prosecution of the work.

July 1, 1889, amount available		$17,678.63
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$3,710.65	
July 1, 1890, amount covered by uncompleted contracts made during fiscal year ending June 30, 1890	13,235.11	
		16,945.76
July 1, 1890, balance available		732.87
Amount appropriated by act of September 19, 1890		100,000.00
Amount available for fiscal year ending June 30, 1891		100,732.87

Amount (estimated) required for preservation of improvement Submitted in compliance with requirements of sections 2 of river and harbor act of 1866 and 1867.	$8,000.00

(See Appendix R 3.)

(*b*) *Tombigbee River, Alabama, from Walker's Bridge to Fulton.*—The present project for the improvement of this section of the river was adopted in 1888, the object being to obtain a good channel for navigation during high water by the removal of snags, logs, and stumps, and cutting overhanging trees, at an estimated cost of $11,000.

The channel was originally only navigable for small rafts, and very troublesome for them.

The amount expended to June 30, 1889, was $2,676.72, and resulted in improving about third of the entire distance according to the project.

The amount expended during the fiscal year ending June 30, 1890, is $1,057.98, and has resulted in improving about one-sixth of the entire distance, so that now about one-half of the work in distance is completed.

July 1, 1889, amount available	$1,323.28
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,057.98
July 1, 1890, balance available	265.30
Amount appropriated by act of September 19, 1890	4,000.00
Amount available for fiscal year ending June 30, 1891	4,265.30
Amount (estimated) required for completion of existing project Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	3,000.00

(See Appendix R 3.)

(*c*) *Tombigbee River, from Fulton to Vienna.*—The project for the improvement of the river from Fulton down to Columbus, 144 miles, was adopted in 1873, the object being to give a good high-water navigation throughout by the removal of snags and overhanging trees.

The channel before improvement was not navigable at all from Fulton down to Cotton Gin Port, 69½ miles. From Cotton Gin Port down to Aberdeen, about 25 miles, it was navigable for small barges carrying about 125 bales of cotton. From Aberdeen down to Columbus, about 49½ miles, navigation was difficult when the river was 12 feet above ordinary low water.

The project for the improvement of the portion of the river between Columbus and Vienna was adopted in 1879, the object being to afford a channel of navigable width and 3 feet deep during ordinary low water.

Before the improvement was commenced the channel was much obstructed by snags and overhanging trees, and there was only 1 foot of water on some of the bars during low water.

The amount expended to June 30, 1889 was about $79,514.42 (exact figures can not be given for reasons stated in Warrior River report), and resulted in the completion of the proposed improvement of that section of the river from Fulton down to Columbus, and in giving such a channel from Columbus down to Vienna that navigation was possible on a 2-foot rise for boats drawing 3 feet, and the accomplishment of over one-half of the work.

The amount of $2,560.15 has been expended during the fiscal year ending June 30, 1890 in preparation of a portion of the plant required for future work and care of property.

July 1, 1889, amount available		$6,535.64
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$2,560.15	
July 1, 1890, amount covered by uncompleted contracts made during fiscal year ending June 30, 1890	3,975.49	
		6,535.64
Amount appropriated by act of September 19, 1890		6,000.00
Amount (estimated) required for preservation of improvement. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		8,000.00

(See Appendix R 3.)

(*d*) *Tombigbee River, below Vienna.*—The project for the improvement of this portion of the river was adopted in 1879, the object being to afford a channel of navigable width and 4 feet deep at ordinary low water from the mouth up to Demopolis, and 3 feet deep from Demopolis up to Vienna. Before the improvement the river was navigable from the mouth up to Bladon Springs, 91 miles, during the entire year; from Bladon Springs up to Demopolis, 100 miles, navigation was suspended about two months yearly during low water.

From Demopolis up to Vienna the channel was much obstructed by snags and overhanging trees, and water was so shoal on the bars that navigation was only attempted on a considerable rise.

The amount expended to June 30, 1889, was about $107,980.95 (exact figures can not be given for reasons stated in Warrior River report), and resulted in obtaining an unobstructed channel with 3 feet depth of water from the mouth up to Tompkin's Bluff, 145 miles, with a 2-foot depth from there up to Kirkpatrick's, 63 miles, and 1-foot depth from there up to Vienna, 74 miles. A considerable portion of the sum expended has been used in preservation of the improvement previously made.

The amount expended in the fiscal year ending June 30, 1890, was $4,311.26, and has been used in care of property and preparation of a portion of the plant required in future prosecution of work.

July 1, 1889, amount available	$4,580.62
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	4,311.26
July 1, 1890, balance available	269.36
Amount (estimated) required for preservation of improvement. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	8,000.00

(See Appendix R 3.)

4. *Noxubee River, Mississippi.*—The present project for the improvement of this river was adopted in 1880, the object being to afford a channel for small river steamers from its mouth up to Macon, Miss., of navigable width and depth when the water is above ordinary low-water stage.

The amount expended to June 30, 1889 was $47,527.52, and resulted in obtaining a channel wholly improved from the mouth of the river up to Macon. The amount expended during the fiscal year ending June 30, 1890, was $2,185.02, and resulted in the preservation of the improvement of the river below Macon.

All work hereafter will be for maintenance of the improvement.

July 1, 1889, amount available	$2,472.48
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	2,185.02
July 1, 1890, balance available	287.46
Amount appropriated by act of September 19, 1890	3,000.00
Amount available for fiscal year ending June 30, 1891	3,287.46

(See Appendix R 4.)

5. *Pascagoula River, Mississippi.*—The present project for the improvement of this river was adopted in 1886, the object being to afford a channel of navigable width and minimum depth of 12 feet at mean low water from Moss Point to the anchorage in the sound, and to maintain the river above Moss Point in its improved condition, at an estimated cost of $78,100 for the channel from Moss Point down, and $2,500 annually for preservation of improvement above Moss Point.

The channel before the improvement commenced had a least depth of 3 feet. This was increased to 7½ feet with a width of 180 feet by dredging, from 1878 to 1880, at a cost of about $42,500.

From the light-house near the mouth of the river throughout the entire length there is a navigable channel, obtained by the removal of snags and overhanging trees, from 1881 to 1884 inclusive, at a cost of about $15,000.

The amount expended to June 30, 1889, is $23,601.18, and resulted in obtaining a channel by dredging through the bar at the mouth of the river with a minimum width of 135 feet and a maximum width of 205 feet, and a minimum depth of 9½ feet at mean low water.

The amount expended during the fiscal year ending June 30, 1890, was $6,242.64, and resulted in the completion of more than one-half of the work needed to complete the project from Moss Point to the mouth of the river. The officer in charge reports that it has been necessary to increase the estimate for completion of this work owing to the hardness of a portion of the material to be dredged.

The amount available is to be expended in the further improvement of the channel, according to project, and in the removal of such obstructions in the river above Moss Point as have lodged during the suspension of work.

July 1, 1889, amount available		$27,004.07
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$6,242.64	
July 1, 1890, outstanding liabilities	4,665.43	
July 1, 1890, amount covered by uncompleted contracts made during fiscal year ending June 30, 1890	14,796.00	
		25,704.07
July 1, 1890, balance available		1,300.00
Amount appropriated by act of September 19, 1890		20,000.00
Amount available for fiscal year ending June 30, 1891		21,300.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		69,000.00

(See Appendix R 5.)

6. *Harbor at Biloxi, Mississippi.*—The present project for the improvement of this harbor was adopted in 1882, the object being to afford a channel of entrance from Mississippi Sound to the wharves at Biloxi of navigable width and 8 feet deep, at an estimated cost of $55,000; the channel before was 4½ feet deep at the shoalest part.

The amount expended to June 30, 1889, was $17,452.19, and resulted in dredging a channel 8 feet deep at mean low water throughout and 126 feet wide from the 8-foot curve outside in Mississippi Sound for a distance of 2,150 feet, thence 84 feet wide for a further distance of 2,000 feet, and thence 124 feet wide for a further distance of 1,030 feet to the 8-foot curve in Biloxi Bay.

The amount expended during the fiscal year ending June 30, 1890, is $176.36 in preparation for work on channel.

July 1, 1889, amount available		$18,547.81
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$176.36	
July 1, 1890, amount covered by uncompleted contracts made during fiscal year ending June 30, 1890	16,371.45	
		16,547.81
July 1, 1890, balance available		2,000.00
Amount appropriated by act of September 19, 1890		9,000.00
Amount available for fiscal year ending June 30, 1891		11,000.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		10,000.00

(See Appendix R 6.)

7. *Pearl River, Mississippi, between Edinburgh and Carthage.*—The project for the improvement of this portion of the river was adopted in 1884, the object being to obtain a good high-water channel throughout for the use of steamers for six or eight months of the year, at an estimated cost of $13,464. Before the improvement was commenced navigation was only possible during very high water, and was even then troublesome.

The amount expended up to the close of the fiscal year ending June 30, 1889, was $5,256.42, and resulted in the improvement of the river from Edinburgh to Carthage, 24¾ miles, so that boats of 3½ feet draught could navigate safely on a 5-foot rise above ordinary low water.

The amount expended during the fiscal year ending June 30, 1890, was $3,864.80, and resulted in the full improvement of the river from Edinburgh down, so that light-draught boats can navigate that portion on a 4½-foot rise above ordinary low water. Project completed.

July 1, 1889, amount available	$4,494.13
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	3,864.60
July 1, 1890, balance available	629.53
Amount appropriated by act of September 19, 1890	5,000.00
Amount available for fiscal year ending June 30, 1891	5,629.53
Amount (estimated) required for preservation of improvement. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	500.00

(See Appendix R 7.)

8. *Pearl River, Mississippi, from Jackson to Carthage.*—The present project for the improvement of this portion of the river was adopted in 1887, the object being to obtain a channel of 2 feet depth at low water and of navigable width throughout, at an estimated cost of $50,000.

Before the improvement was commenced, navigation, even during high water, was difficult on account of snags and overhanging trees.

The amount expended to June 30, 1889, was $22,956.73, and resulted in such improvement of 89 miles of river from Carthage down that boats of 3 feet draught of water could navigate this distance on a 3-foot rise above ordinary low water, and the remaining distance 16 miles on a 4-foot rise.

The amount expended during the fiscal year ending June 30, 1890, is $190 for care of property.

July 1, 1889, amount available	$293.27
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	190.00
July 1, 1890, balance available	103.27
Amount appropriated by act of September 19, 1890	3,000.00
Amount available for fiscal year ending June 30, 1891	3,103.27
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	23,500.00

(See Appendix R. 8.)

9. *Pearl River, Mississippi, below Jackson.*—The present project for the improvement of this portion of the river was adopted in 1885, the object being to afford a channel 2 feet deep at ordinary low water and of navigable width from the mouth of the river up to Jackson, at an estimated cost of $145,940.

Before the improvement the river was not navigable at all at low water, and difficult at high water.

The amount expended on the work to June 30, 1889, was $99,354.96, and resulted in the complete improvement of that section of the river from the head of the cut-off near the head of West Pearl River down to the mouth at the Rigolets, a distance of 51 miles, the complete improvement of 25 miles of the river from the head of the cut-off up to Pools Bluff for a width of 100 feet, and the partial improvement of the river from Jackson down to the cut-off, a distance of 239 miles.

The amount expended during the fiscal year ending June 30, 1890, was $3,748.59, and resulted in the complete improvement of 30 miles of river from Pools Bluff to Wheats Field, for a width of 100 feet, and partial improvement of 50 miles of river from Wheats Field up to Columbia.

Condition of this part of the river is now such that light-draught boats can navigate from the mouth at the Rigolets, La., to Wheats Field, Mississippi, 106 miles, all the year; from Wheats Field up to Columbia, Miss., 50 miles, on a 6-foot rise, and from Columbia to Jackson on a 7-foot rise.

July 1, 1889, amount available	$7,770.04
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	3,748.59
July 1, 1890, balance available	4,021.45
Amount appropriated by act of September 19, 1890	20,000.00
Amount available for fiscal year ending June 30, 1891	24,021.45
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	35,000.00

(See Appendix R 9.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENT, TO COMPLY WITH REQUIREMENTS OF RIVER AND HARBOR ACT OF AUGUST 11, 1888.

It appearing from the preliminary examination made by the local engineer that the following localities are worthy of improvement, and the public necessity therefor being apparent from the facts and reasons reported, which are concurred in by the Chief of Engineers, Major Damrell was charged with and completed their survey, the results of which were transmitted to Congress and printed in Ex. Doc's. of the Fifty-first Congress, first session.

1. *Warrior River, Alabama, from Tuscaloosa to Demopolis; Tombigbee River from its mouth up to Vienna, and Tombigbee River between Vienna and Cotton Gin.*—Printed as House Ex. Doc. 156. (See also Appendix R 10.)

2. *Sipsey River, Alabama, from the Tombigbee River at Vienna to Texas, with a view of easy transportation of coal.*—Printed as House Ex. Doc. 198. (See also Appendix R 11.)

INSPECTION OF THE IMPROVEMENT OF THE SOUTH PASS OF THE MISSISSIPPI RIVER.

Inspecting officer, Capt. W. L. Fisk, Corps of Engineers.

The inspecting officer in his annual report states that the legal channel was maintained during the year except for the first five days in October, 1889, when the central depth between the extreme ends of the jetties was only 29.6 feet, instead of the required 30 feet.

During the year the least depth beyond the ends of the jetties, and on a direct course from there to sea was 28.3 feet, while in the channel turning to the eastward there was a least depth of 31.5 feet with a least width of 130 feet between the 30 feet curves.

The least depth between the head of the Passes and the Gulf during the year was 27 feet, which prevailed but a short time.

In December last a steam-ship drawing 27 feet went out through the jetties in a dense fog, without the slightest trouble.

In April last a steam-ship was aground in the upper part of the pass, in consequence of not being in the proper part of the channel.

The demurrer filed in the cases of the pilots and masters indicted for violations of the "rules regulating the navigation of South Pass of the Mississippi River," and which at the date of the last Annual Report was held under advisement, was over-ruled and the validity of the rules established. One pilot was brought to trial but was acquitted.

July 1, 1889, amount available	$11,042.27
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	10,000.00
July 1, 1890, balance available	1,042.27
Amount appropriated by act of August 11, 1888	10,000.00
Amount available for fiscal year ending June 30, 1891	11,042.27

(See Appendix S.)

IMPROVEMENT OF VARIOUS WATER-COURSES IN THE STATE OF LOUISIANA—IMPROVEMENT OF SABINE PASS AND OF SABINE AND NECHES RIVERS, TEXAS.

Officer in charge, Capt. W. L. Fisk, Corps of Engineers; Division Engineer, Col. C. B. Comstock, Corps of Engineers.

1. *Tchefuncte River and Bogue Falia, Louisana.*—The river is navi-

gable for steamers drawing 5 feet to Old Landing, about 10 or 12 miles above its mouth, and then for lighter-draught schooners to Covington, about 2 miles further up on the Bogue Falia. The bar at the mouth of the river had a depth of 4½ feet on it at the lowest stage of the water. The project for the improvement of the river was made in 1880, and contemplated the removal of overhanging trees, logs, etc., in channel, and the dredging of the bar at its mouth.

The obstructions, such as overhanging trees, logs, etc., were removed, but the bar at the mouth was not dredged, as it would be likely to re-form.

To prevent this, or retard its re-formation, the officer in charge in 1884 recommended building a breakwater extending 2,500 feet into the Lake, and then dredging a channel through the bar.

With the two appropriations of $1,500 each, made in 1881 and 1882, the obstructions below Covington were removed and part of the unexpended balance was used for the construction of 820 feet of the breakwater.

The original estimated cost of improving the river was $5,460, but this did not include building a breakwater across the bar.

The project, as modified in 1884, was estimated to cost $20,400, but has not yet received the sanction of Congress.

At the close of the fiscal year ending June 30, 1885, $3,000 had been expended on this improvement, at which time the navigation had been improved for schooners to Covington by removal of snags and overhanging trees, and it is thought that the breakwater has retarded the drift of sand on the bar at the river's mouth.

Twenty-five hundred dollars was appropriated by Congress in August, 1886, to improve Bogue Falia between Old Landing and Covington. Early in 1887 operations began and channels 5 feet in depth and 30 to 60 feet wide were cut through the bars in this stretch of bayou, giving better navigation for schooners to and from Covington.

Fifty-five hundred dollars was expended on this stream up to the close of the fiscal year ending June 30, 1889.

Amount appropriated by act of September 19, 1890..... $1,000.00

(See Appendix T 1.)

2. *Tickfaw River and its tributaries, Louisiana.*—In 1879 Congress authorized an examination of this river. A project was submitted in 1881 to clean out the river and its navigable branches—the Natalbany, Blood, and Pontchatoula rivers—by removing logs, snags, trees, etc., at an estimated cost of $10,230.

In 1881, 1882, 1886, and 1888, Congress made appropriations aggregating $7,000, and 20 miles of the Tickfaw, and the Natalbany to Springfield, the head of navigation, have been improved. Work was also done on the Ponchatoula as far as it was thought advisable.

The Blood River was also cleaned out as far as navigable. Only a little wood and some saw-logs are carried or floated on this stream.

The improvement is not permanent, as obstructions will continue to form in all these streams, but an annual appropriation of $1,000 will keep them in good order.

With the appropriation of 1886 the work was completed according to the original project, but obstructions having re-formed in the mean time it was necessary to use the appropriation of 1888, $1,000, for removing them.

Up to the close of the fiscal year ending June 30, 1889, $6,981.81 had been expended on this stream.

July 1, 1889, amount available	$18.20
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	18.20
Amount appropriated by act of September 19, 1890	1,000.00

(See Appendix T 2.)

3. *Amite River, Louisiana.*—Before improvement the river was obstructed by snags, sunken logs, and trees. One or two small steamboats and a number of sailing-vessels were employed in the commerce of the river. In 1880 a project was made to remove obstructions above Bayou Manchac, so as to get 5 feet depth as far as appropriations would permit. Eight thousand dollars was appropriated, and the improvement of 40 miles of river above Bayou Manchac was contracted for. The work was of little benefit to commerce. In 1881 $5,000 was appropriated to continue the work. In 1883 the project was modified so as to improve the river below Bayou Manchac and work was done upon about 8 miles of river.

In 1886 $2,000 was appropriated to continue the improvement. This was applied to that portion of the river below the mouth of Bayou Manchac, and principally between there and Port Vincent. Work was resumed in November, 1886, and completed in January, 1887, and the channel cleared.

In 1888 $5,000 was appropriated, of which $2,500 was made applicable to the Bayou Manchac by the terms of the act.

Under this appropriation Bayou Manchac was cleaned out from its mouth to Hereford Landing, a distance of 9½ miles, and the obstructions that had re-formed in Amite River below the mouth of the Manchac were removed.

The improvement is not a permanent one as new obstructions will form from the caving banks.

The estimated annual expense of keeping this stream clear is $2,000. The original estimated cost of the work on Amite River only was $23,760.

Up to the close of the fiscal year ending June 30, 1889, $19,375.96 had been expended on this stream.

July 1, 1889, amount available	$624.04
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	110.04
July 1, 1890, balance available	514.04
Amount appropriated by act of September 19, 1890	3,800.00
Amount available for fiscal year ending June 30, 1891	4,314.04

(See Appendix T 3.)

4. *Bayou La Fourche, Louisiana.*—The original project adopted in 1879, was for the removal from the channel of snags, shoals, wrecks, and overhanging trees, and under it $28,754.45 was expended up to June 30, 1885, giving much relief to navigation.

In 1888 Congress appropriated $50,000 for the improvement of the bayou on the plan of Lieutenant Crosby, Corps of Engineers, dated June 11, 1886, and provided for dredging for the immediate relief of low-water navigation.

Lieutenant Crosby's project was for a lock at the head of the bayou connecting it with the Mississippi River, and subsequent dredging of the bayou channel to a width of 75 feet with a depth of 5 feet at mean low water of the Gulf. The estimated cost was $450,000 with an annual expenditure of $8,000 for operation and maintenance.

The appropriation of 1888, became available so late in the season it was only possible to dredge the bar at the head of the Bayou, but this let in so much water from the Mississippi River that the flat-boats were able to commence running again at once, and had no further trouble, the water beginning to rise soon after.

The remainder of the dredging was advertised later, but the only bid received being too high it was rejected, and authority obtained to hire the dredge *Geo. F. Rootes*, which began dredging September 11, 1889, and continued until January 18, 1890, when the water had risen so much that satisfactory work could no longer be done.

Up to the close of the fiscal year ending June 30, 1889, $33,157.09, had been expended on this stream.

July 1, 1889, amount available	$46,842.91
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	11,435.42
July 1, 1890, balance available	35,407.49
Amount appropriated by act of September 19, 1890	50,000.00
Amount available for fiscal year ending June 30, 1891	85,407.49
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	400,000.00

(See Appendix T 4.)

5. *Bayou Terrebonne, Louisiana.*—This stream was examined in 1879 and the cost of its improvement by dredging a channel to Houma, 4 feet deep at mean low water of Gulf, and clearing of obstructions, was estimated at $18,800, afterwards increased to $38,800.

When work was commenced in 1880, Bayou Terrebonne was little more than a drainage ditch in many places, being about 11 feet wide where dredging began.

To June 30, 1889, there had been appropriated $38,800 and expended $34,480.33, completing the work to Houma according to project, and allowing freight along the bayou to be sent by steamers or lighters to the railroad at that place.

Up to the close of the fiscal year ending June 30, 1889, $35,280.33 had been expended on this stream.

July 1, 1889, amount available	$3,519.67
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	524.88
July 1, 1890, balance available	2,994.79

(See Appendix T 5.)

6. *Bayou Plaquemine, Louisiana.*—To comply with the requirements of the river and harbor act of August 5, 1886, a preliminary examination and survey were made of the mouth of Plaquemine, with a view to its connection with the Mississippi River by locks, and also Bayou Plaquemine and other connecting streams to form the best route to Grand Lake, La. The report of the result of the survey is printed in Senate Ex. Doc. No. 21, Forty-ninth Congress, second session, and also as Appendix S 21 of the Report of the Chief of Engineers for 1887.

The proposed project provides for the opening of the water-route indicated by removal of snags and dredging and constructing a lock at the mouth of Bayou Plaquemine, at an estimated cost of $1,708,250.

The river and harbor act of August 11, 1888, appropriated $100,000 for this work.

By the terms of the above act the $100,000 appropriated was to secure the mouth of the bayou from further caving, and to dredge a channel 60 feet wide and 6 feet deep from deep water up to Plaquemine Dike.

On the recommendation of the officer in charge the first part of this work was transferred to the officer in charge of the fourth district of the Mississippi River, who had plant available for this work, thus avoiding the expense of building it. The other portion of the work was commenced early in June by the Government dredge that had been working at the mouth of Neches River, Texas, during the winter and spring, and progressed satisfactorily until stopped by high water April 30, 1890.

Up to the close of the fiscal year ending June 30, 1889, $3,882.66 had been expended on this stream.

July 1, 1889, amount available		$96,314.20
Amount reserved by Chief of Engineers		170.00
		96,484.20
July 1, 1890, amount expended during fiscal year exclusive of liabilities outstanding July 1, 1889	$42,538.76	
July 1, 1890, outstanding liabilities	5,709.00	
		48,247.76
July 1, 1890, balance available		48,236.44
Amount appropriated by act of September 19, 1890		100,000.00
Amount available for fiscal year ending June 30, 1891		148,236.44
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		1,508,250.00

(See Appendix T 6.)

7. *Bayou Courtableau, Louisiana.*—During the high-water season the backwater from the Atchafalaya always forms a large sand deposit known as Little Devil Bar at the mouth of the Courtableau.

When the water fell a number of small bayous on the lower side of the Courtableau formerly allowed so much water to escape into the swamps that there was not sufficient current to scour out Little Devil Bar, and during low water it was necessary to transfer freight around it by a tramway.

An examination was made in 1879 and the cost of improvement below Port Barré was estimated at $40,000, the project being to close the run-out bayous, forcing all the water to flow over Little Devil Bar and scour it out, after which a timber lock and dam were to be constructed to give slackwater navigation to Washington, La. In 1883 the estimate was increased to $78,500 and provided for a masonry lock. Up to June 30, 1889, there had been appropriated $29,000, of which $27,910.61 had been expended in closing run-out bayous with the effect of partially removing the bar.

During the year ending June 30, 1890, the low-water season was so short that it was only possible to make a few repairs upon the dams already in place, and as the high water still entirely covers all the work its present condition and effect can not be determined. It is very doubtful if, with all the run-outs closed, a channel navigable at low water can be maintained over Little Devil Bar, which under any circumstances will certainly form again at each high water of the Atchafalaya.

Up to the close of the fiscal year ending June 30, 1889, $24,350.49 had been expended on this stream.

July 1, 1889, amount available	$4,636.61
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	3,547.22
July 1, 1890, balance available	1,089.39
Amount appropriated by act of September 19, 1890	2,200.00
Amount available for fiscal year ending June 30, 1891	3,289.39

(See Appendix T 7.)

8. *Calcasieu River and Pass, Louisiana.*—In 1874, and again in 1882–'83, dredged channels were cut through the flats in Calcasieu Lake above Calcasieu Pass.

The dredged channel was 8 feet deep and 70 feet wide by 7,500 feet long.

In 1885 this channel had again shoaled to a depth of 3½ feet and needed redredging, but an unfortunate wording of the appropriation, "improving Calcasieu River," prevented its application to this work. In 1886 this was remedied and funds appropriated for Calcasieu River became available for both the pass and the river. Contracts were made in 1886 for building two lines of piles and planking about 120 feet apart and a mile or more in length, between which a channel 100 feet in width and 6 feet in depth was to be dredged and the excavated material thrown outside of the lines of the piles.

The excavation of a channel 100 feet wide and 6 feet deep through a bar at the junction of the river and lake was included in the contract.

Work was commenced on the lines of piles and planking in the winter of 1886. In the spring of 1887 operations were resumed and the pile-work and planking partially completed, when the contract was annulled January 3, 1888.

During this long delay the revetment was badly damaged by the teredo and the project was modified as far as to omit the revetment.

Work was begun in March and completed August 31, 1888, since which time nothing has been done. The results will not be permanent, as the dredged channel will undoubtedly shoal again.

Up to the close of the fiscal year ending June 30, 1889, $19,203.71 had been expended on this stream.

July 1, 1889, amount available	$10,000.00
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	23.00
July 1, 1890, balance available	9,977.00
Amount appropriated by act of September 19, 1890	75,000.00
Amount available for fiscal year ending June 30, 1891	84,977.00

(See Appendix T 8.)

9. *Sabine River, Louisiana and Texas.*—At the commencement of the improvement of the river there was a depth of 3½ feet on the bar at its mouth and also above the town of Orange. Logs, snags, etc., above here interfered with navigation. To June 30, 1889, there had been appropriated for this work $34,700 of which $30,760.39 had been expended.

In 1880 a channel 6 feet deep, 70 to 100 feet wide, was dredged through the bar. In 1881 several small cuts to avoid bends obstructed with logs were made above Orange.

The dredged channel over the bar at the mouth is somewhat obstructed by logs, but the depth is now sufficient for present demands of navigation and commerce.

An examination above Orange showed many snags in parts of the channel and a project was prepared and contract entered into for the expenditure of the remaining balance in closing both branches of Old River at the head of the Narrows with pile, brush and earth dams, to throw all the water into the useful channel, and removing the snags, overhanging trees, etc.

The smaller Old River channel was closed and most of the piles driven for the larger dam when a sudden rise in the river washed out many of the piles in the latter. The river remaining so high that satisfactory work could not be done, the contract was extended to the next low-water season. There has been no loss to the United States as the contract provides for payment after the satisfactory completion and delivery of all the work. The contractor states that the completed dam is now in excellent condition.

July 1, 1889, amount available	$4,517.66
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	578.05
July 1, 1890, balance available	3,939.61

(See Appendix T 9.)

10. *Neches River, Texas.*—Before this river was improved the bar at its mouth had only 3 feet of water over it, and snags and fallen trees obstructed navigation between Yellow Bluff and Bevilsport. To June 30, 1889, $33,000 had been appropriated for this work, of which $28,842.12 had been expended.

In 1880 a channel was dredged through the bar at the mouth of the river 5 feet deep and 30 to 60 feet in width. In 1882 the river between Yellow Bluff and Bevilsport was cleared of obstructions.

The bar at the mouth had again shoaled, so that at extreme low water there was only a navigable depth of about 3 feet. The channel was dredged to a depth of 5 feet by the Government dredge, which had been at work at Calcasieu Pass, and the work was completed in May, 1889, since which time no work has been done.

The improvement will not be permanent, as the bar will re-form.

July 1, 1889, amount available	$4,167.84
July 1, 1890, balance available	4,167.84

(See Appendix T 10.)

11. *Sabine Pass, Texas.*—This bar had upon it originally a least depth of between 6 and 7 feet, the depth being so uniform on the crest that it could hardly be said there was a definite channel.

The original project of improvement was for deepening by dredging, and under this plan about $165,000 was expended and a channel 12 feet in depth made, but it soon disappeared.

In 1882 the present project for building two jetties was adopted, there being then less than 7 feet on the bar. Under this project to June 30, 1889, there had been expended $861,200.74, the last preceding survey showing a channel with a least depth of 9 feet and a least width of 200 feet.

During the fiscal year ending June 30, 1890, $132,357.16 was expended. The contract under execution at the date of the last Annual Report was closed during last December, and a survey made during that month shows a channel with a least depth of 10 feet at mean low water, and a least width of about 100 feet with soundings of 9½ feet or more on either side over a width of more than 1,000 feet.

July 1, 1889, amount available	$20,488.22
July 1, 1889, amount covered by existing contracts	72,665.35
	93,153.57
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	89,339.54
July 1, 1890, balance available	3,814.03
Amount appropriated by act of September 19, 1890	300,000.00
Amount available for fiscal year ending June 30, 1891	303,814.03

Amount (estimated) required for completion of existing project 1,501,250.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix T 11.)

SECURING MOUTH OF BAYOU PLAQUEMINE, LOUISIANA, FROM FURTHER CAVING.

Officer in charge, Capt. Dan C. Kingman, Corps of Engineers; Division Engineer, Col. C. B. Comstock, Corps of Engineers.

The river and harbor act of August 11, 1888, in making an appropriation for improving Bayou Plaquemine, Louisiana, provides for securing the mouth of the bayou from further caving, and an allotment of $75,000 was made for this purpose and the work assigned to the charge of Capt. Dan C. Kingman, Corps of Engineers, he having under his direction, in connection with the work of the Mississippi River Commission, a plant suitable for the operations proposed.

The approved project under this allotment required the construction of four sloping spur-dikes, placed at intervals of about 1,000 feet, two of them to be above and two below the mouth of the bayou. That portion of the dike that is below low water is to be built of cribs made of timber and willow brush and filled with stone. Above low water, and extending to the levee, the spur is built of earth and protected where necessary by a pavement of stone.

No plant was available for this work until late in the season, and consequently only two spurs were constructed. They were subjected to the high water of the present season, but apparently suffered but trifling injury, though their exact condition can only be determined by a careful survey. No caving of the bank has taken place in the vicinity of the spurs.

A money statement will be found attached to report on improvement of Bayou Plaquemine, Louisiana, page 179.

(See Appendix U.)

IMPROVEMENT OF RIVERS AND HARBORS IN THE STATE OF TEXAS.

Officer in charge, Maj. Charles J. Allen, Corps of Engineers, since November 20, 1889, having under his immediate orders since that date, First Lieut. William C. Langfitt, Corps of Engineers; Division Engineer, Col. C. B. Comstock, Corps of Engineers. These works were in charge of Maj. O. H. Ernst, Corps of Engineers, until November 2, 1889; in temporary charge of Lieut. William C. Langfitt, Corps of Engineers, from November 2 to 20, 1889.

1. *Entrance to Galveston Harbor, Texas.*—The obstructions to deep-water navigation at this harbor have been the outer and inner bars. On the former the natural depth was 12 feet, and on the latter about 13 feet, both at mean-low tide.

The present project for the improvement of this locality was adopted in 1874, modified in 1880, and again modified in 1886, the object being to deepen the channel so as to admit sea-going vessels of the deepest draught. The projects prior to 1874 related to dredging operations on a small scale.

The total amount expended to June 30, 1889, including $100,000 subscribed in 1883 by the city of Galveston was $2,067,176.27. It resulted in deepening the channel over the outer bar to about 13¼ feet, and that over the inner bar to about 21 feet. The amount expended during the year is $205,935.39. It has resulted in the maintenance of 13¼ feet on the outer bar, and an increase in depth of about 1 foot on the inner bar.

July 1, 1889, amount available		$38,763.46
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889, and exclusive of payments made on contracts in force July 1, 1889	$19,022.19	
July 1, 1890, outstanding liabilities	123.25	
		19,145.44
July 1, 1890, balance available		19,618.02
Amount appropriated by act of September 19, 1890		500,000.00
Amount available for fiscal year ending June 30, 1891		519,618.02
Amount (estimated) required for completion of existing project		5,700,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892		1,000,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix V 1.)

2. *Ship-channel in Galveston Bay, Texas.*—This is a channel dredged by the United States Government from Bolivar Channel to Morgan's Cut, the latter terminating at a point 5 miles from Morgan's Canal, which is an excavation made across Morgan's Point at the mouth of San Jacinto River. Morgan's Canal and Morgan's Cut are works executed by the Buffalo Bayou Ship-channel Company chartered under the laws of Texas.

The natural depth on the line of the Galveston Ship-channel averaged 8½ feet at mean low tide, with a depth, at some places, of but 7 feet.

The present project for this improvement was adopted in 1871 and modified in 1877, the object being to excavate and maintain a channel 12 feet deep and 100 feet wide at bottom through Galveston Bay from Bolivar Channel to Morgan's Cut, a distance of about 18.9 miles.

The total amount expended to June 30, 1889, was $488,944.24. It resulted in the excavation of a channel having an average depth of 14½ feet through Redfish Bar, a length of about 2 miles, which, with some fluctuations, had been maintained since 1883, and in the excavation of a channel not less than 12 feet deep and 100 feet wide for a length of about 10 miles from Bolivar Channel to Redfish bar, and for a length of about 7 miles immediately north of Redfish Bar. The portion between Bolivar Channel and Redfish Bar, having been then completed about a year, had shoaled to an average depth of about 11.61 feet and width of about 100 feet. The average period which had elapsed since the execution of the work between Redfish and Morgan's Cut was, in June, 1889, only two months, so that no important deterioration in recent work was, at that time, observable.

The amount expended during the fiscal year ending June 30, 1890,

was $40,869.98. The work consisted in redredging 6,225 linear feet of channel between Redfish Bar and Morgan's Cut which had not been excavated by the contractors to full depth. An examination of the ship-channel made in June, 1890, showed the ruling depth from Bolivar Channel to Morgan's Cut to be 10 feet at mean low tide, the average depth being somewhat greater, and that the channel through Redfish Bar had not materially changed since June, 1889.

The work is not capable of permanent completion. It is estimated that an annual expenditure of about $80,000 will be required to maintain it.

The work of improvement of ship-channel in Galveston Bay having, in July, 1889, reached the point in the bay at which the southern extremity of Morgan's Cut is located, the officer in charge, under instructions from this office, called upon the Buffalo Bayou Ship-channel Company to execute its agreement of January 22, 1881 (see Annual Report, Chief of Engineers for 1881, Part II, page 1338), to transfer to the United States its works at Morgan's Point.

July 1, 1889, amount available		*$32,730.24
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889, and exclusive of payments made on contracts in force July 1, 1889	$14,916.78	
July 1, 1890, outstanding liabilities	1,127.68	
		16,044.46
July 1, 1890, balance available		16,685.78
Amount appropriated by act of September 19, 1890		40,000.00
Amount available for fiscal year ending June 30, 1891		56,685.78

(See Appendix V 2.)

3. *Trinity River, Texas.*—The natural channel on the bar at the mouth of the river was narrow and shoal. The present, which is also the original, project for improvement was adopted in 1873 and modified in 1889, the object being to afford a navigable channel 6 feet deep through the bar at the mouth of the middle pass. The modification of project in 1889 consisted principally in the projection of two long parallel jetties, 275 feet apart, instead of dredging. The total amount expended to June 30, 1889, was $34,535.97, including $7,500 expended in 1882 in removing a bar at Liberty. It resulted in no improvement of a permanent nature. Amount expended during the past fiscal year, $12,419.60. It resulted in increasing the depth on the bar from 3 feet 2 inches to 3 feet 6 inches, a gain of 4 inches, and a straightening of the channel.

July 1, 1889, amount available	$12,464.03
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	12,419.60
July 1, 1890, balance available	44.43
Amount appropriated by act of September 19, 1890	10,000.00
Amount available for fiscal year ending June 30, 1891	10,044.43
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	32,500.00

(See Appendix V 3.)

* On July 1, 1889, the amount to complete contract then in force was estimated at $49,905.71; but the contract was completed for $24,815.52; hence the balance available July 1, 1889, is increased by $25,090.19.

4. *Buffalo Bayou, Texas.*—The channel between the city of Houston and Simms' Bayou, a distance of 11 miles, the extent of bayou under improvement was, in its natural condition, narrow and tortuous and the natural depth in many places was not more than 6 feet. The project for improvement was adopted in 1881, the object being to straighten, widen, and deepen the channel to a width of 100 feet at bottom and depth of 12 feet, and to remove such snags, stumps, and overhanging trees as were obstructions to navigation between Houston and Simms' Bayou. The total amount expended to June 30, 1889, was $138,393.82. It resulted in clearing the channel of the most prominent stumps, snags, and overhanging trees, in easing some of the bends and in removing such shoals as obstructed a 7-foot navigation. Total expended during the fiscal year ending June 30, 1890, $5,297.91. It resulted in further easing navigation by the straightening of a bend about 6 miles below Houston. The obstructions are renewed in greater or less degree each year. The project is not capable of permanent completion.

July 1, 1889, amount available	*$719.27
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889, and exclusive of payments made on contracts in force July 1, 1889	661.00
July 1, 1890, balance available	58.27
Amount appropriated by act of September 19, 1890	25,000.00
Amount available for fiscal year ending June 30, 1891	25,058.27
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	216,549.00

(See Appendix V 4.)

5. *Aransas Pass and Bay up to Rockport and Corpus Christi, Texas.*—In its natural state the pass was moving bodily in a southwesterly direction at the rate of about 260 feet per year, and the channel depth over the bar varied from 7 to 9½ feet. The present (original also) project for the improvement of this locality was adopted in 1879 and modified in 1887, the object being to fix the position of the pass and to provide a navigable channel at least 20 feet deep through the bar. The total amount expended to June 30, 1889, including $9,938.93 subscribed by citizens of Rockport and Corpus Christi, was $546,869.34. It resulted in fixing the position of the pass. The amount expended during the past fiscal year was $3,547.24, principally in caring for the existing works, the funds available being too small to warrant commencing work on jetties. Congress by act approved May 12, 1890, authorized the Aransas Pass Harbor Company, under certain conditions, to improve this pass.

July 1, 1889, amount available	$44,319.59
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	3,547.24
July 1, 1890, balance available	40,772.35

(See Appendix V 5.)

6. *Harbor at Brazos Santiago, Texas.*—In its natural state the channel over this bar was shifting and its depth varied from 6 to 8 feet. The present (original) project for its improvement was adopted in 1881, the

*On July 1, 1889, the amount to complete the contract then in force was estimated to be $4,233.44; but it actually required $4,636.91: hence the amount available July 1, 1889, is reduced by $403.47

object being to fix the position of the channel over the bar at the entrance and to deepen it. The total amount expended to June 30, 1889, was $188,650.23 (besides an appropriation of $6,000 in 1878 applied to removing a wreck). It has resulted in no useful effect upon the bar, and the works heretofore constructed have practically disappeared. The amount expended during the year was $898.36. It was applied to the keeping of a record of commercial statistics and incidental expenses. The officer in charge considers that $600,000 is the least amount which should be available before beginning the construction of jetties. He suggests that if the importance of the port be not considered sufficient to justify so large an appropriation, the improvement be deferred for the present. The amount required for the entire completion of the project is $1,071,090.23.

July 1, 1889, amount available		$58,849.77
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$668.36	
July 1, 1890, outstanding liabilities	230.00	
		898.36
July 1, 1890, balance available		57,951.41
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		1,071,090.23

(See Appendix V 6.)

EXAMINATION AND SURVEY FOR IMPROVEMENT, TO COMPLY WITH REQUIREMENTS OF RIVER AND HARBOR ACT OF AUGUST 11, 1888.

It appearing from the preliminary examination made by the local engineer for *removal of bar at mouth of Cedar Bayou where it empties into Galveston Bay, Texas*, that the locality is worthy of improvement, and the public necessity therefor being apparent from the facts and reasons reported, which are concurred in by the Chief of Engineers, Major Ernst was charged with its survey. The survey having been completed by his successor, Major Allen, the results were transmitted to Congress and printed as House Ex. Doc. 84, Fifty-first Congress, first session. (See also Appendix V 7.)

WESTERN RIVERS.

IMPROVEMENT OF RED RIVER, AND OF CERTAIN RIVERS IN THE STATE OF ARKANSAS, AND OF CERTAIN RIVERS IN THE STATES OF LOUISIANA, MISSISSIPPI, AND TENNESSEE, TRIBUTARY TO THE MISSISSIPPI—WATER-GAUGES ON THE MISSISSIPPI AND ITS PRINCIPAL TRIBUTARIES.

Officer in charge, Capt. J. H. Willard, Corps of Engineers; Division Engineer, Col. C. B. Comstock, Corps of Engineers.

1. *Red River, Louisiana and Arkansas.*—This improvement was begun in 1828, and appropriations aggregating $535,765.50 were made between 1828 and 1852. Between 1841 and 1852 no appropriation was made, and a longer interval elapsed between 1852 and 1872, during which the results of former work were lost.

The present improvement, from Fulton, Ark., to the Atchafalaya, commenced in 1872, at which time navigation above Shreveport, La., was almost impossible on account of the great raft; the falls at Alex-

andria were impassable at low water; navigation during low stages between Shreveport and Grand Ecore, La., was affected seriously by the gradual enlargement of Tone's Bayou Outlet, which depleted the main channel of the river below; and the entire river was much obstructed by snags, sunken logs, wrecks, leaning trees, etc.

The project contemplated the removal of raft, snags, wrecks, and other obstructions; closing Tone's Bayou Outlet; opening a channel through the falls at Alexandria; and deepening the channel at shoal places. Also protection of caving banks at Alexandria. Owing to the nature of the work, it must be continuous, and no estimate of cost was made on this account.

The amount expended to June 30, 1889, was $839,232.92. The great raft was opened in 1873, and operations since have prevented its forming again and secured an enlarged channel with greater depth everywhere. The channel excavation and dam at the Falls of Alexandria were completed in 1885, and a dam and training-wall for protecting the caving bank were built the same year. The removal of snags and clearing the banks for general improvement of the river were not begun until 1878, but since 1885 operations have been confined to this class of work. The act of August 11, 1888, provided for continuing work in Cypress Bayou and in Bayou Dorcheat (tributaries of Red River) by allotments of $5,000 for each from the appropriation for Red River, and work in both streams was resumed in 1889.

In the past year three snag-boats and a dredge continued the work of removing obstructions whenever the stage of water would permit, and the snag-boats patrolled the river keeping drift in motion and preventing formation of raft during high water.

A small snag-boat and a dredge were employed on the Cypress Bayou route from December 31 to March 8 in removing obstructions and widening and deepening the cuts. The balance available for this work June 30 was only $325.82.

Work in Bayou Dorcheat, etc., was continued from July 1 to October 9, when it was completed. This consisted of going over the work done in 1884, cutting the brush which had grown since and removing dangerous stumps, leaning timber, etc. Nothing further is required for this stream.

Field work of the survey from Fulton to the Atchafalaya was continued down-stream to Grand Bend, La., near Alexandria, and 406 miles below Fulton, and suspended the middle of February, after which a small force was retained in the office to work up the notes. To complete the project, about 100 miles of the lower river have to be surveyed, a part of the lines revised between Shreveport and Caspiana, La., and connections made with the survey of Bayou Pierre, and secondary triangulation from the mouth of Atchafalaya back to Fulton. The balance available for this work June 30 was $111.60.

The amounts expended during the past year were:

For general improvement (including liabilities $15.14)	$23,751.56
For Cypress Bayou, etc. (including liabilities $1.07)	2,918.73
For Bayou Dorcheat	1,999.16
For survey (including liabilities $3.81)	20,881.32
Total	49,550.77

Red River frequently is jammed in a few hours with acres of drift, and raft formation is prevented only by prompt service of snag-boats. Should jams occur when funds are exhausted, and none expected for some time, it is probable that new rafts would form, diverting the river

from the bed on which thousands of dollars have been spent, to lo itself in the low lands and bayous, destroying by the way a fertile cou try that has been reclaimed from overflow by the improvement and t construction of levees by the State of Louisiana.

July 1, 1889, amount available		$62,767.
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$49,530.75	
July 1, 1890, outstanding liabilities	20.02	
		49,550.
July 1, 1890, balance available		13,216.
Amount appropriated by act of September 19, 1890		100,000.
Amount available for fiscal year ending June 30, 1891		113,216.

(See Appendix W 1.)

2. *Ouachita and Black Rivers, Arkansas and Louisiana.*—The i provement of Ouachita River commenced in 1871. Black River, t connecting stream between Ouachita and Red Rivers, was added und the same head of appropriation by the act of 1884. The original pr ect contemplated improvement by a system of locks and dams, but w abandoned in 1874 on account of its cost and doubtful utility. T present project contemplates removing snags, logs, wrecks, leaning ti ber, etc., obstructing navigation, and the improvement of shoal plac between Camden, Ark., and the mouth of Black River, 341 miles. I estimate of cost is given, as the nature of the work requires that it continuous.

The total amount expended to June 30, 1889, was $311,665.03, which $198,077.16 were applied to operations under the present proje This work consisted principally of removing logs and snags from t channel and cutting leaning timber. Stone and brush wing-dams we built at some of the shoals, increasing the channel depth from 1 to ov 3 feet.

In the past fiscal year a large snag-boat was employed from Augu 17 until September 20, thoroughly removing all snags, etc., obstructi the channel between Taylor's Bar, 25 miles below Monroe, La., and t mouth of Black River. A chopping party commenced work at Camd December 20 and continued down stream 12 miles until January when a rise stopped operations. Nothing has been done since, on a count of continued high water.

Since the project for improvement by locks and dams was abandone three examinations have been made with a view to slack-water navig tion, the last in 1889, and the reports on all agree that work should co tinue under the adopted project for the present.

July 1, 1889, amount available		$15,384.
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$8,660.08	
July 1, 1890, outstanding liabilities	2.89	
		8,662.
July 1, 1890, balance available		7,172.
Amount appropriated by act of September 19, 1890		15,000.
Amount available for fiscal year ending June 30, 1891		22,172.

(See Appendix W 2).

3. *Ouachita River, Arkansas, above Camden.*—The project for this i provement, based on an examination made in 1887, contemplated moving snags, cutting leaning timber, and building brush-dams at t

shoals between Camden and Arkadelphia, Ark., at an estimated cost of $9,000.

The act of August 11, 1888, appropriated $9,000 to complete the work.

A chopping party commenced operations at Arkadelphia, September 25, 1889, and continued down-stream to Camden, which was reached December 19. This work put the river in fair condition for navigation above Camden to Arkadelphia, at stages permitting boats to run to the former place. There is no commerce at present, but a small boat is building at Arkadelphia to run in this trade.

The available balance will be expended next low-water season in going over the work and completing the project.

July 1, 1889, amount available	$9,000.00
July 1, 1890, amount expended during fiscal year	6,599.26
July 1, 1890, balance available	2,400.74

(See Appendix W 3.)

4. *Bayou D'Arbonne, Louisiana.*—The project for this improvement was adopted in 1884, and contemplates the removal of snags, logs, wrecks, leaning trees, etc., obstructing navigation from Stein's Bluff, on the Corney Branch, to the mouth of D'Arbonne, 42½ miles, at an estimated cost of $15,000.

The amount expended to June 30, 1889, was $8,000. The removal of obstructions increased the period of navigation about one month.

In the past year work was continued from July 1 to August 2, when the funds were exhausted. The work has enabled boats of double the capacity of those used formerly to navigate the stream during high water, and freight rates have been reduced fully one-half.

The work is not permanent, as new obstructions are forming continually.

July 1, 1889, amount available	$1,000.00
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,000.00
Amount appropriated by act of September 19, 1890	2,000.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	4,000.00

(See Appendix W 4.)

5. *Little River, Louisiana.*—The project for this work was based upon an examination made in 1887, and contemplated removing sunken logs and cutting the most obstructive leaning timber between Catahoula Lake and Trinity, La., at a cost of $2,500.

The act of August 11, 1888, appropriated $2,500 for this purpose.

The sum of $1,708.27 was expended in the fiscal year 1889, and the balance during the past fiscal year.

The work contemplated by the project having been completed, no further estimate is made.

July 1, 1889, amount available	$791.73
July 1 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	791.73

(See Appendix W 5.)

6. *Bayou Bartholomew, Louisiana and Arkansas.*—This improvement was begun in 1881, the project contemplating the removal of snags, logs, wrecks, leaning timber, etc., obstructing navigation between Baxter, Ark., and the mouth, a distance estimated to be 213 miles.

The amount expended to June 30, 1889, was $23,000. Work l extended over nearly the entire portion of the bayou included in project, and lessened the dangers of navigation greatly.

In the past fiscal year a chopping party and light snag-boat c menced removing obstructions early in August, and continued u the available balance was expended.

Before the improvement commenced three months was the aver duration of the navigable season. Now boats of double the capa are employed for six months of the year, make trips in one-half time formerly required, and have reduced freight rates 50 per cent.

Permanent improvement can not be secured, as obstructions forming continually.

July 1, 1889, amount available		$5,00
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$4,995.10	
July 1, 1890, outstanding liabilities	.34	
		4,99
July 1, 1890, balance available		
Amount appropriated by act of September 19, 1890		5,00
Amount available for fiscal year ending June 30, 1891		5,00

(See Appendix W 6.)

7. *Bayou Bœuf, Louisiana.*—The project for improving this bayou adopted in 1881, and contemplated removing snags, logs, leaning timl etc., obstructing navigation between Wallace's Landing and the mou about 280 miles. Three outlets of the bayou near Point Jefferson, were examined in 1884 and their closure recommended at an estima cost of $8,500.

The amount expended to June 30, 1889, was $25,022.48. The remc of obstructions lessened the danger of navigation and enabled boat run to Point Jefferson, 19 miles below Wallace's, at high stages. 1888 and 1889 the outlets were closed as follows: Outlet No. 1 closed substantially, the second by a heavy dam at a lower elevat and the third by a low dam, this being all that could be done with su appropriations.

In the past fiscal year three week's work in December was done b light snag-boat, thoroughly clearing the obstructions from the 60 m above the mouth. This exhausted the small balance of the appropriat

During the overflow from the Mississippi River last spring the d closing the outlets were destroyed. It is essential that they be resto at once, as the water ultimately will leave the main channel if the lets remain open, and navigation of the bayou will be destroyed.

July 1, 1889, amount available		$97
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$955.43	
July 1, 1890, outstanding liabilities	22.00	
		97
July 1, 1890, balance available		
Amount appropriated by act of September 19, 1890		5,00
Amount available for fiscal year ending June 30, 1891		5,00

(See Appendix W 7.)

8. *Tensas River and Bayou Maçon, Louisiana.*—The project for proving Tensas River was adopted in 1881, and contemplated remov snags, logs, and leaning timber obstructing navigation between Dal and its mouth, about 180 miles, at an estimated cost of $23,000. Ba

Macon, a tributary, was added under the same head of appropriation by act of 1884, and the project contemplates removing the same class of obstructions between Floyd and its mouth; about 130 miles, at an estimated cost of $17,000.

The amount expended to June 30, 1889, was $15,768.99; $7,425 of which had been applied to improving Tensas River, and $8,343.99 to Bayou Maçon. The obstructions were removed as far as practicable with these amounts, but as new obstructions are forming continually permanent results were not attained.

No work was done in the past fiscal year, the balance available being too small.

July 1, 1889, amount available	$231.01
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	104.25
July 1, 1890, balance available	126.76
Amount appropriated by act of September 19, 1890	5,000.00
Amount available for fiscal year ending June 30, 1891	5,126.76
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	19,000.00

(See Appendix W 8.)

9. *Big Black River, Mississippi.*—The project for this improvement contemplated removing snags, logs, wrecks, and leaning trees obstructing navigation between the mouth and Cox's Ferry, 130 miles above, at an estimated cost of $32,000. Such improvement can not be permanent, as new obstructions are added from time to time.

The first appropriation for this work, by act of 1884, was applied to removing obstructions in the 75 miles above the mouth. No work has been done since.

The appropriation by act of 1886 contained the following proviso: "No part of this appropriation shall be used until the State of Mississippi shall have first caused the bridges south of the Vicksburg and Meridian Railroad to be so constructed as not to obstruct the navigation of said stream." This requirement has not been complied with, one bridge yet obstructing navigation, located about 25 miles below the railroad crossing referred to in the act.

July 1, 1889, amount available	$5,000
July 1, 1890, balance available	5,000
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	22,000

(See Appendix W 9.)

10. *Yazoo River, Mississippi.*—Work in this river was begun in 1873. The project contemplates removal of snags, logs, wrecks, and leaning timber obstructing navigation throughout the entire length of the stream. New obstructions are brought into the river every year by floods, sliding banks, etc., and no estimates for permanent improvement have been made on this account.

The amount expended to June 30, 1889, was $177,557.74. Prior to improvement the river was obstructed by a large number of wrecks, and by snags and leaning timber. Nine of the steam-boats sunk during the war were removed by contract in 1873–'74, and snag-boats have operated in the river since whenever funds were available, keeping it in navigable condition from its head to its mouth the year round.

In the past fiscal year a large snag-boat was employed on this work from October 3 to November 8, benefiting low-water navigation greatly. A pumping dredge-boat, authorized by act of August 11, 1888, was purchased.

The shifting bar at the mouth of the river is the most serious obstruction to navigation. Boats that could navigate the principal streams of the Yazoo Valley system (about 900 miles) without hindrance, are prevented from entering or leaving without lightening and at times navigation across the bar is stopped altogether.

July 1, 1889, amount available		$12,442.26
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$9,317.39	
July 1, 1890, outstanding liabilities	.34	
		9,317.73
July 1, 1890, balance available		3,124.53
Amount appropriated by act of September 19, 1890		25,000.00
Amount available for fiscal year ending June 30, 1891		28,124.53

(See Appendix W 10.)

11. *Tchula Lake, Mississippi.*—The project for this improvement was adopted in 1881, and contemplates removing snags, logs, leaning timber, etc., obstructing navigation, to permit light-draught steam-boats to enter the lake earlier in the season.

The amount expended to June 30, 1890, was $10,278.57.

No work was done during the past fiscal year.

The work is of such nature that it must be gone over from time to time to remove obstructions that are forming continually.

July 1, 1889, amount available	$1,721.43
July 1, 1890, balance available	1,721.43
Amount appropriated by act of September 19, 1890	3,000.00
Amount available for fiscal year ending June 30, 1891	4,721.43

(See Appendix W 11.)

12. *Tallahatchee River, Mississippi.*—This improvement was begun in 1879. The project contemplated removing snags, sunken logs, and leaning timber obstructing low-water navigation below mouth of Coldwater, a distance of 165 miles, and a wreck in the channel 8 miles above the mouth. The estimated cost of such improvement was $40,000, if completed in two seasons.

The amount expended to June 30, 1889, was $29,548.11, of which $10,000 were expended above mouth of Coldwater (a part of the river not included in the project), as required by the terms of the appropriations. The remainder was expended between the mouth of Tallahatchee and Sharkey's Landing, 100 miles above. Before work commenced the river was navigable about six months of the year. Now boats run to Sharkey's the year round.

In the past fiscal year a large snag-boat was employed from November 8 to December 24, when the funds were exhausted.

A snag-boat should be used for a short time each year to remove heavy obstructions from this river.

July 1, 1889, amount available	$2,951.89
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	2,951.89
Amount appropriated by act of September 19, 1890	5,000.00

Amount (estimated) required for completion of existing project..... Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	$12,500.00

(See Appendix W 12.)

13. *Steele's Bayou, Mississippi.*—Work in this bayou commenced in 1884. The project contemplates removing snags, stumps, leaning timber, etc., obstructing navigation during high water.

The amount expended to June 30, 1889, for this purpose, was $6,829.35.

A light-draught steam-boat was employed from July 12 to 17, 1889, in removing obstructions from the lower part of the bayou.

July 1, 1889, amount available.....	$670.65
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889.....	670.65
Amount appropriated by act of September 19, 1890	2,500.00

(See Appendix W 13.)

14. *Big Sunflower River, Mississippi.*—Work in this river commenced in 1879. The project contemplated building wing-dams to scour a channel from 3 feet to 40 inches deep at the bars, and the removal of snags, sunken logs, and leaning timber obstructing navigation, at an estimated cost of $66,000.

The amount expended to June 30, 1889, was $50,243.73.

Operations extended over the navigable portion of the river, from Clarksdale to its mouth; an increased depth of channel of from 18 inches to 3½ feet was gained at the bars where dams were built, and a large number of obstructions were removed. The improvement is not permanent, as new obstructions are added every year.

In the past fiscal year the removal of obstructions and construction of dams were continued for sixteen days with a small steam-boat hired for the purpose.

Before the improvement commenced the river was navigable for light boats about six months each year, and it was an unusual thing for a boat to make a trip under eight days. Now the river is navigable the year round, but with difficulty about three months of the time, and boats make the trip in five days. Insurance rates have been reduced about one-fifth, and freight rates more than one-half. The country along the river is filling up rapidly with settlers, which is attributable in part to the improvement of navigation.

July 1, 1889, amount available.....	$1,756.27
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889.....	1,756.27
Amount appropriated by act of September 19, 1890	5,000.00
Amount (estimated) required for completion of existing project..... Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	9,000.00

(See Appendix W 14.)

15. *Big Hatchee River, Tennessee.*—This improvement was begun in 1880. The project contemplates removing logs, snags, leaning timber, etc., obstructing navigation from Bolivar, Tenn., to the mouth, about 240 miles, to render the river navigable for light-draught boats throughout the year. The improvement will not be permanent, as new obstructions are added from time to time.

Before work commenced navigation was virtually suspended by reason of the obstructions. The amount expended to June 30, 1889,

was $23,989.02, rendering the river navigable about seven montl the year.

In the past fiscal year operations were continued with a small h propelled snag-boat, from August 19 to October 31, and effective v was done in the way of removing sunken logs from the channel b Rialto, 57 miles from the mouth.

July 1, 1889, amount available		$3,0
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$3,010.17	
July 1, 1890, outstanding liabilities	.38	
		3,0
July 1, 1890, balance available		
Amount appropriated by act of September 19, 1890		5,0
Amount available for fiscal year ending June 30, 1891		5,0

(See Appendix W 15.)

16. *Forked Deer River, Tennessee.*—Work in South Fork of this r commenced in 1883. The act of August 11, 1888, added North I and main river under the general head of improving Forked Deer Ri The project contemplates removing snags, logs, leaning timber, from South Fork below Jackson, North Fork below Dyersburgh, the main river.

The amount expended to June 30, 1889, was $17,979.21, of w $12,500 were applied to South Fork, $3,862.85 to North Fork, $1,616.36 to the main stream. The two forks were put in fairly navigable condition, but in the main stream no material benefit gained.

In the past fiscal year work was continued in the main river North Fork until the balances of the last appropriation were expen viz: Main river, $883.64; North Fork, $637.15.

South Fork is obstructed by numerous bridges which render st boat navigation impracticable, and for the present further improve is not deemed necessary. The project for North Fork is complete

July 1, 1889, amount available	$1,5
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,5
Amount appropriated by act of September 19, 1890	2,5

(See Appendix W 16.)

17. *Water-gauges on the Mississippi River and its principal tributari* These gauges were established in 1871 under joint resolution of gress, approved February 21, 1871 (section 5252, Revised Statutes). the purpose of securing information from continuous records, wi view to protecting the alluvial basin of the Mississippi against c flow, improving navigation, and giving reliable reports for the be of river-men and planters.

The amount expended to June 30, 1889, was $74,233.71. Nine gauges were established originally, and an additional one at Nash Tenn., in 1873. Observations commenced at each station as soon a gauge was set up, and with a few exceptions have continued regul since. The gauge at Rock Island, Ill., was abandoned in 1879. In bulletins were erected at stations on the Mississippi for the purpos giving passing boats the gauge readings. Since February 1, 1 the gauges have been read twice a day; formerly they were read once.

Owing to small and irregular appropriations, caused by frequent

ures of appropriations for rivers and harbors, many difficulties were encountered in making this work continuous, until the passage of the act of August 11, 1888, section 6 of which provided a permanent, indefinite, appropriation for securing uninterrupted gauging.

In the past year observations, inspections, and repairs were continued. Larger bulletins were set up on the Mississippi, and the old bulletins repaired for use at stations on the tributaries, which heretofore have not been provided with them. New gauges were established at Fulton and Garland, Ark., and Shreveport, La., on Red River, and at Donaldsonville, La., on the Mississippi. The gauge at Fort Leavenworth, Kans., was abandoned, but will be maintained by the Missouri River Commission. Efforts are being made to find the benches of the Mississippi Delta Survey, and thus connect observations of early years with those since 1871, and also to connect the gauges with the same datum plane.

Additional gauges are needed at various places on the principal tributaries, and requests are made from time to time for new gauges and bulletins by persons interested in navigation.

July 1, 1889, amount available, (provided by act of August 11, 1888.)		$9,600.00
July 1, 1890, amount expended during fiscal year	$7,718.34	
July 1, 1890, amount allotted for gaugings at St. Paul	600.00	
July 1, 1890, outstanding liabilities	5.19	
		8,323.53
July 1, 1890, balance unexpended		1,276.47

(See Appendix W 17.)

To comply with a resolution of the House of Representatives of February 6, 1890, the local engineer, Captain Willard, was directed to make a special report respecting the improvement of *Cypress Bayou and the lakes between Jefferson, Tex., and Shreveport, La.* This report was transmitted to Congress, and published as House Ex. Doc. 252, Fifty-first Congress, first session. (See also Appendix W 18.)

IMPROVEMENT OF ARKANSAS RIVER; OF RIVERS IN THE STATE OF ARKANSAS, AND THE BLACK, ST. FRANCIS, AND LITTLE RIVERS, IN ARKANSAS AND MISSOURI.

Officer in charge, Capt. H. S Taber, Corps of Engineers; Division Engineer, Col. C. B. Comstock, Corps of Engineers.

1. *Red River above Fulton, Arkansas.*—The first appropriation was made by act approved August 5, 1886. Prior to this time, this river was choked with masses of drift-wood, isolated snags, and logs, and many overhanging trees added to the difficulties of navigation. The originally adopted project contemplates high and medium stage navigation only. Six thousand nine hundred and eleven dollars and fifty cents had been expended up to June 30, 1888, removing nearly 800 dangerous low-water snags. By the act which became a law August 11, 1888, $3,000 was appropriated. During the fiscal year ending June 30, 1889, $3,077.30 had been expended in the continuance of the original project.

July 1, 1889, amount available	$11.20
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	11.20
Amount appropriated by act of September 19, 1890	2,000.00

(See Appendix X 1.)

2. *Little Red River, Arkansas.*—The only improvements ever attempted upon this river were made in 1872. Prior to this work, many overhanging trees, and a large number of snags interfered with navigation in the lower reaches; and many bowlders obstructed flatboat and raft navigation, in the reach above the present town of Judsonia. Most of the overhanging trees and snags were removed as high as Judsonia, and the bowlders remained untouched to the end of June 30, 1886.

By acts, approved August 5, 1886, and August 11, 1888, $8,400 were appropriated for removing the bowlders above Judsonia, and dredging a channel through the Shoals, 3 miles below. Of this sum $5,621.80 had been expended to June 30, 1889, removing the bowlders, building a dredge and barges, and caring for property.

During fiscal year ending June 30, 1890, $1,531.53 have been expended in the continuation of the project, high water having prevented the expenditure of the entire sum in the completion of the project.

July 1, 1889, amount available		$2,069.39
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$1,531.53	
July 1, 1890, outstanding liabilities	35.00	
		1,566.53
July 1, 1890, balance available		502.86
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		3,000.00

(See Appendix X 2.)

3. *Removing obstructions in Arkansas River, Arkansas and Kansas.*—Prior to the first improvements in 1833, shifting sand-bars, numerous drift-piles, and dangerous snags constituted the obstacles to navigation in the lower reaches, and gravel and rock shoals, with a few snags and many overhanging trees, constituted those of the upper. Except for a few special reaches, like the Fort Smith and Pine Bluff, the general plan of improvement has consisted in snagging operations, including the cutting of overhanging trees, in building wing-dams to improve the shoals, and in surveys, looking toward plans for its permanent improvement.

The appropriations to June 30, 1890, amount to $465,251.37. Of this sum there had been expended to June 30, 1889, $380,568.68.

During fiscal year ending June 30, 1890, $10,719.99 were expended in snagging operations at low water, and in completing the maps of the river.

July 1, 1889, amount available		$12,157.88
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$10,719.99	
July 1, 1890, outstanding liabilities	81.67	
		10,801.66
July 1, 1890, balance available		1,356.22
Amount appropriated by act of September 19, 1890		20,000.00
Amount available for fiscal year ending June 30, 1891		21,356.22
Amount (estimated) required for completion of existing project annually. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		35,000.00

(See Appendix X 3.)

4. *Arkansas River, Arkansas.*—By act of August 5, 1886, $75,000 was appropriated for continuing the improvement of Arkansas River, in accordance with the plan and recommendations contained in Appendix V. 13, House Ex. Doc. No. 1, Forty-ninth Congress, first session, which provided that $8,000 be expended at Pine Bluff; $13,000 at Fort Smith, and $10,000 at Dardanelle, or so much thereof as may be necessary. The approved project for the expenditure of this sum is as follows: At Pine Bluff, the $8,000 to be used in extending and repairing the dikes, and for protecting the town front. At Fort Smith the $13,000 to be expended in erecting a permeable dike a little above the town to retain the channel along the city wharves. At Dardanelle the $10,000 to be expended in erecting a permeable dike above the town to remove the sand-bar now in front of the wharves.

From Little Rock to the mouth the balance and so much as may not be required at the three places above specified, to be expended in the erection of permeable dikes at the worst places, looking towards the permanent improvement of the river to give at least a depth of 5 feet at extreme low water. By act of August 11, 1888, $150,000 was appropriated under this head as follows:

Improving Arkansas River, Ark.: Continuing improvement: $150,000. *Provided* That nothing herein contained shall authorize the Secretary of War to enter upon the project of improvement of said river as set forth in the report of the Board of Engineers on improvement of the Arkansas River from Wichita, Kans., to its mouth, dated New York City, March 16, 1888, and contained in House Executive Document No. 234, first session, Fiftieth Congress: *Provided,* That the Secretary of War shall expend the appropriation under this head with reference to the final improvement of this river as contemplated in the Report of the Chief of Engineers, for the year ending July 1, 1885, and as authorized in the act for the improvement of rivers and harbors, approved August 5, 1886, and in House Executive Document No. 90, Forty-ninth Congress, first session, said methods to be applied, as the Secretary of War may direct, at such points between Wichita, Kansas, and the navigable mouth of the Arkansas River, at its junction with the Mississippi River, as he may deem for the best interests of commerce. And all moneys now to the credit of different sections of the Arkansas River, other than the appropriations for the operating of snag boats, shall be available for use under this head; and in future the engineer in charge of this work and the Secretary of War shall make report upon the progress and needs of this work under this head, instead of reporting upon disconnected projects, as heretofore. Nothing herein contained shall be understood to prevent the Secretary of War from applying any part or all of the funds previously appropriated for use at Fort Smith, Dardanelle, in Pine Bluff reach, or from expending not exceeding $4,000 to remove the bar in front of Van Buren, or from allotting not exceeding $8,000 as a contingent fund for the expenditure in Pine Bluff Reach.

The approved project for the expenditure of this sum may likewise be summarized as follows:

At Pine Bluff the same as above. At Van Buren the $4,000 to be expended in erecting a permeable dike at a suitable point a little above the town, and upon the opposite side of the river, to contract the channel and prevent it from leaving the city wharves. From Fort Gibson, Indian Territory, to the mouth of the river, the balance to be expended in the erection of permeable dikes, and in one instance, by rock excavation, at the worst places or the places at which serious interference with the largest amount of commerce occurs, so far as the amount of the appropriation will permit, looking toward the permanent improvement of the river to give the channel as provided under the act of August 5, 1886, from Little Rock to the mouth; and an all-year-round depth of water of at least 2 feet from Little Rock, Ark., to Fort Gibson, Indian Territory.

Before operations were begun at Fort Smith the old jetty at that place, built in 1877 and 1878, had so far disappeared as to render no service, and the river was about to throw a bar along the wharves of

the town, cutting off all approach to the wharf at low water or at medium stage. From Fort Gibson to the mouth of the river the river consists of alternating bars and caving banks, with crossings more or less troublesome at low water, a few of the latter operating to effectually close the river to navigation at extreme low water for even boats drawing but 2 feet of water.

During fiscal year ending June 30, 1890, $4,684.56 have been expended at Pine Bluff in the erection of a new dike and in repairing and extending two old ones.

From Fort Gibson, Indian Territory, to the mouth of the river, $52,786.19 have been expended according to projects.

Numerous rises and limited amount of plant have rendered it impossible to give that relief to navigation which an ordinary season would have permitted. There were erected three dikes just above Fort Smith, aggregating 1,200 feet in length, and one dike 300 feet long near Wilson's Rocks.

Two quarter-boats and ten barges were built, and material accumulated for three dikes 3 miles below Pine Bluff. One of these dikes was partly completed, a new hull for the quarter-boat *Lizette* was begun, and some material accumulated for the work at Moore's Rocks.

July 1, 1889, amount available		$122,295.82
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$51,007.60	
July 1, 1890, outstanding liabilities	2,384.34	
		53,391.94
July 1, 1890, balance available		68,903.88
Amount appropriated by act of September 19, 1890		180,000.00
Amount available for fiscal year ending June 30, 1891		248,903.88
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		3,472,479.00

(See Appendix X 4.)

5. *Petit Jean River, Arkansas.*—Before improvement this river was obstructed by snags, logs, masses of drift-wood, overhanging trees, and shoals. The original project for improvement contemplated rendering it navigable, during high and medium stages of water, as high as Danville, Ark., by cutting the overhanging trees and cutting up the snags, logs, and drift. Three thousand five hundred dollars were expended in the execution of this to June 30, 1888. The appropriation made by act approved August 11, 1888, amounts to $2,500, and limits the work to below the bridge at Rocky Crossing. The new project for this provides for removing portions of the shoals known as Slaty Crossing and Robinson's Ridge, and certain timber from the low-water channel.

During fiscal year ending June 30, 1890, no work was done, due to the anomalous conditions in reference to continued high water, rendering it impossible to begin the work with any certainty of completing it without a long suspension.

July 1, 1889, amount available	$2,450.52
July 1, 1890, balance available	2,450.52
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	3,500.00

(See Appendix X 5.)

6. *Fourche River, Arkansas.*—The improvement of this stream was begun in 1879 under the act approved March 3, 1879.

Prior to any improvement its channel was choked with snags, logs, and drift, and heavy timber overhung its banks. Several bad shoals also impeded navigation. Up to June 30, 1886, $21,000 had been expended in removing the greater part of the obstructions. By act approved August 5, 1886, $5,000 was appropriated for removing rock shoals, situated about 4 miles below Perryville. At the close of the fiscal year ending June 30, 1888, this sum had been expended, completing a channel about 500 yards long, 30 feet wide, and 2 feet deep at low water through this shoal.

Amount appropriated by act of September 19, 1890	$7,500.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	150.00

(See Appendix X 6.)

7. *White River, Arkansas.*—Prior to improvement this river was choked with drift-piles, logs, and snags in its lower portion, and from Batesville up gravel-bars, rocky shoals, channel-bowlders, and overhanging trees, impeded navigation. The originally adopted project consisted in snagging operations and blasting of ledges, and bowlders, and dam-building to remove gravel-bars or to close chutes. The first separate appropriation for this river was made by act approved July 5, 1884. Provision for a survey of the river from Forsythe, Mo., to its mouth was added to the original project. At that time the river was in excellent navigable condition for boats drawing not to exceed 3 feet of water, from its mouth to Newport, Ark. From Newport to Batesville there were many troublesome snags, and from Batesville to Buffalo Shoals there were numerous bad shoals, rendering navigation very uncertain. From Buffalo Shoals to Forsythe, Mo., there were many fine reaches of river, but the depth of water on Buffalo Shoals and others prevented any navigation at ordinary stages of water. Up to June 30, 1888, $51,359.65 had been expended. This completed the survey, plotted the notes, published the maps, effectively improved the most dangerous shoals between Buffalo Shoals and Batesville, and removed the more dangerous snags from Batesville to the mouth. By the act of August 11, 1888, $25,000 was appropriated. Fifty-eight thousand dollars was specified as the sum which could be properly expended the first fiscal year. The present plan provides for the maintenance, at low water, of a channel 2 feet deep between Newport and Buffalo Shoals, and a channel of not less than 5 feet deep, at low water, from Newport to the mouth, and also for a limited amount of snagging operations while these improvements are in progress. The result between Newport and Buffalo Shoals is to be accomplished by the erection of solid wing-dams and some rock excavations. From Newport to the mouth is to be accomplished by the erection of low permeable spur-dikes, to give the necessary depth of water to the shoals, yet not to remove the shoals to a point below or to cave the opposite banks.

During fiscal year ending June 30, 1890, $15,058.58 were expended in the work of improvement, beginning at Buffalo Shoals, and working towards Batesville, working 39 miles of river and leaving 47 to reach Batesville, and also collecting material and beginning work upon dike at Newport. Exhaustion of funds and high water precluded more extensive work.

July 1, 1889, amount available		$16,257.90
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	14,730.25	
July 1, 1890, outstanding liabilities	526.50	
		15,256.75
July 1, 1890, balance available		1,001.15
Amount appropriated by act of September 19, 1890		30,000.00
Amount available for fiscal year ending June 30, 1891		31,001.15

Amount (estimated) required for completion of existing project	53,815.00
Amount (estimated) required for snagging annually	8,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1886 and 1887.	

(See Appendix X 7.)

8. *Cache River, Arkansas.*—The first appropriation ever made for this reach of river became available August 11, 1888. Prior to this time its channel was choked with logs and snags, overhanging trees interfered with smoke stacks, and several shoals interfered with low-water navigation. The project proposes the removal of logs, snags, and overhanging trees from the town of Riverside, Ark., to the mouth of the river. Seven thousand dollars was the amount appropriated, $3,000 for the construction of a snag-boat, and $4,000 for the operating expenses; working at or near extreme low water, the boat being constructed of light draught for this purpose. During the fiscal year ending June 30, 1889, $3,970.06 were expended building the snag-boat *Riverside*, equipping the same, and removing 67 snags and logs, 14 drift-piles, and all overhanging trees for 3 miles of river, beginning at Riverside and working down. During the fiscal year ending June 30, 1890, the snagging operations were continued. Between the railroad bridge (crossing of the Bald Knob and Memphis branch of the Missouri Pacific System) and Walker's Ferry, there were 341 snags removed, 158 overhanging trees cut, 4 trees deadened, and 20 piles of drift and logs removed. The obstructions encountered were more formidable than was expected, or then appeared from the reconnaissance, and there are some 35 miles of river yet to be worked over.

July 1, 1889, amount available	$2,621.3[illegible]
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	2,614.[illegible]
July 1, 1890, balance available	7.[illegible]

Amount (estimated) required for completion of existing project	3,000.
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix X 8.)

9. *Black River, Arkansas and Missouri.*—Before any improveme[illegible] were made upon this river, its channel was choked with snags and lo[illegible] and obstructed by overhanging trees, and in many places shoals interfe[illegible] with its navigation at low water by any but very light draught bo[illegible] The original plan for its improvement contemplated the removal of [illegible] obstructions and the improvement of the shoals, the latter by w[illegible] dams. A few sloughs were to be closed up so as to confine the wate[illegible] the main channel. Up to June 30, 1889, $58,363.59 had been expen[illegible] for these purposes, and good progress made toward opening the ri[illegible] through to Poplar Bluff, Mo.

During fiscal year, ending June 30, 1890, $2,878.81 were expended [illegible] such a manner as to do thorough work up to a few miles above [illegible] *mouth of Current* River, from the mouth, and also from Poplar Blu[illegible]

Mo., to Corning, Ark.; and indifferent work just taking out the worst obstructions to get the snag-boat through the balance of the distance. This unimproved reach is a constant feeder of snags into the improved reach below, and should be improved, to maintain the improved river.

July 1, 1889, amount available	$2,878.81
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	2,878.81
Amount appropriated by act of September 19, 1890	5,000.00
Amount (estimated) required for completion of existing project, annually Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	8,000.00

(See Appendix X 9.)

10. *Black River, Missouri.*—The first improvements attempted upon this reach of river were made in the years 1881 and 1882. Prior to this work, its channel was choked with snags and logs and obstructed by overhanging trees, and in many places shoals interfered with its navigation at low water, by any but very light draught boats. The original plan for its improvement contemplated the removal of the obstructions and the improvement of the shoals, the latter by wing-dams. A few sloughs were to be closed up so as to confine the water to the main channel. Up to June 30, 1888, $6,000 had been expended which had opened up about 20 miles of river from Poplar Bluff towards the mouth. Owing to the difficulty in getting suitable appliances up to this reach, it was carried on under great disadvantages. During fiscal year ending June 30, 1889, the snag-boat *Henry Sheldon* (specially constructed for use on this river) was worked to Poplar Bluff from below and operated from there down the river, expending $6,562.30 rapidly and effectively, clearing the reach worked of obstructions, erecting a strong dam (at the head of Dan River, a chute of the Black River) raising the water in the other chute and carrying the work to the Arkansas State line, removing the greater part of the dangerous snags and making a good beginning upon overhanging timber.

During the fiscal year ending June 30, 1890, the small balance, $199.20, was expended in conjunction with the general appropriation, "Improving the Black River, Arkansas and Missouri," in the running expenses of the snag-boat *Henry Sheldon.*

July 1, 1889, amount available	$199.20
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	199.20
Amount appropriated by act of September 19, 1890	7,000.00

(See Appendix X 10.)

11. *St. Francis River, Arkansas.*—The first appropriation was made March 2, 1833, prior to which this river was choked with drift-logs, snags, and its waters spread out through a great variety of sloughs, while overhanging trees added to the difficulty of navigation. The originally adopted project was principally for snagging operations, and attempts have been made to close up some of the many sloughs. Appropriations for this river, having been united with the White River, exactly how much had been expended upon the St. Francis River to June 30, 1884, can not well be stated. July 5, 1884. the first separate appropriation was made, amounting to $12,000. August 5, 1886, $8,000 more followed. By act of August 11, 1888, $4,000 was appropriated.

During fiscal year ending June 30, 1890, $2,112.19 have been expended in the continuance of the regular project and, in conjunction with the

appropriation, "Improving Little River, Missouri, and Arkansas," in building a new hull for the operating boat.

July 1, 1889, amount available	$2,114.61
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	2,112.19
July 1, 1890, balance available	2.42
Amount appropriated by act of September 19, 1890	4,000.00
Amount available for fiscal year ending June 30, 1891	4,002.42
Amount (estimated) required for completion of existing project, annually. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	8,000.00

(See Appendix X 11.)

12. *St. Francis River, Missouri.*—The appropriation available is the first ever made for this reach of river. Prior to the work done in the fiscal year ending June 30, 1889, its channel was choked with logs and snags, overhanging trees interfered with smoke stacks, and several shoals interfered with low-water navigation. The estimate, $7,300, proposed the removal of the shoals about 12 miles below Greenville, and the removal of snags and other obstructions.

The amount appropriated, act approved August 11, 1888, being inadequate, the present project contemplates removing the obstructions only, and no work upon the shoals except incidentally. Up to June 30, 1889, $3,002.21 had been expended, cutting a channel through the "Big Drift" and carrying out other provisions of the project.

During the fiscal year ending June 30, 1890, the balance available, $1,531.04, was expended during low-water season between Wappapello and St. Francis, leaving 65 to 80 miles of river yet to be worked.

July 1, 1889, amount available	$1,531.04
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,531.04
Amount appropriated by act of September 19, 1890	10,500.00

(See Appendix X 12.)

13. *Little River, Missouri and Arkansas.*—Before improvement this river was obstructed by snags, logs, masses of drift-wood, and shoals, and was divided into two chutes. The project for improvement contemplates prolonging medium-stage navigation by closing one of the chutes and removing the obstructions enumerated from the other. The snag-boat for this work not being available, no work was done during the fiscal year ending June 30, 1889.

Owing to damage to the hull of the boat that was to be used upon this improvement, and owing to the long-continued overflows, no work was done until nearly the close of the fiscal year.

July 1, 1889, amount available		$4,970.31
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$2,072.72	
July 1, 1890, outstanding liabilities	845.30	
		2,918.02
July 1, 1890, balance available		2,052.29
Amount appropriated by act of September 19, 1890		3,000.00
Amount available for fiscal year ending June 30, 1891		5,052.29

(See Appendix X 13.)

REMOVING SNAGS AND WRECKS FROM THE MISSISSIPPI RIVER—IMPROVEMENT OF THE MISSISSIPPI BETWEEN THE MOUTHS OF THE ILLINOIS AND OHIO RIVERS—IMPROVEMENT OF OSAGE AND GASCONADE RIVERS, MISSOURI.

Officer in charge, Maj. A. M. Miller, Corps of Engineers; Division Engineer, Col. C. B. Comstock, Corps of Engineers.

1. *Removing snags and wrecks from the Mississippi River.*—The navigation on this river was very much interfered with by the numerous snags, logs, etc., which were lodged in the channel, and to which a new accession was brought down on each rise of the river, thus constantly adding new and unknown obstructions to those already there. A large number of wrecks also occupied the channel and were very dangerous to the safety of passing boats.

For the removal of these obstructions appropriations were made as early as 1824, and the project consisted in building boats suitable for removing the snags, etc., and operating them whenever the stage of water was favorable for the work and funds were available.

The total amount expended for this purpose can not be definitely given, as previous to the appropriation made by act of March 3, 1879, a general amount was appropriated to be applied to several streams as their needs required. From March 3, 1879, when the first specific appropriation was made, up to June 30, 1889, $632,939.53 was expended for this purpose. The navigation of the river has been very materially improved by this method, and the danger of accidents to boats lessened.

During the fiscal year ending June 30, 1890, $85,263.27 was expended. Two snag-boats were employed between the mouth of the Missouri River and Bayou Sara, La., removing obstructions. The boats worked for a total of twelve months, removing 2,861 snags, cutting down 12,112 trees, removing 23 drift-piles, and 1 wreck, and traveling a distance of 10,797 miles, thereby greatly benefiting navigation and commerce.

Much needed repairs were also made to the snag-boats, and they are now in good condition to resume work as soon as the stage of water will permit.

An annual appropriation having been made for carrying on this work, no further estimate is submitted.

July 1, 1889, amount available		$32,971.95
Amount drawn under section 7, act of August 11, 1888		55,000.00
		87,971.95
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$82,061.12	
July 1, 1890, amount re-deposited	5,910.83	
		87,971.95
July 1, 1890, outstanding liabilities		419.11
July 1, 1890, amount available for fiscal year 1890–'91		100,000.00

(See Appendix Y 1.)

2. *Mississippi River, between the Ohio and Illinois rivers.*—The original condition of the navigable channel of this portion of the Mississippi River, before the work of improvement was begun, was such that the natural depth at low water was in many places from 3½ to 4 feet and the water was scattered by islands, which formed sloughs behind them, thus wasting the water available for low-water navigation.

The project for improvement adopted consists in closing these sloughs and, by contraction works, the concentration of the water between banks 2,500 feet apart, the *object being thereby* to obtain a depth of

8 feet in the channel between Saint Louis and Cairo and 6 feet between Grafton and Saint Louis at standard low water, or at a stage corresponding to a reading of 4 feet on the Saint Louis gauge.

The amount expended up to the close of the fiscal year ending June 30, 1889, was $3,905,153.51. The condition of the improvement during the year past has been such that during stages above 4 feet, except on very rapidly falling river approaching this stage, a depth of 8 feet has been maintained in the channel from Saint Louis to Lucas' Crossing, a distance of 30 miles, as far as the work of improvement had been carried on June 30, 1890.

The amount expended during the fiscal year ending June 30, 1890, was $129,268.78. No appropriation having been made for this year, little work could be accomplished. The work consisted principally in the continuation of the general plan, and has resulted in a very decided improvement of the channel as to direction and depth.

During the fiscal year work was carried on at the following localities:

Piasa Dam.—This work is situated above Alton. A portion of the dam, 1,100 feet long, was repaired and raised to a height 6 feet above low water, in order to concentrate the flow of water in the steam-boat channel; an opening was left between the Missouri shore and end of the dam, in order, if possible, to cut a channel along this shore, as this would rectify the channel. If this can be accomplished the present channel through the dam will be closed. The amount expended there was $5,577.11, and for this amount 2,604.9 cubic yards of stone placed in the dam.

Twin Hollows—West Side.—The work here consisted in the protection of the artificial banks formed by the contraction works. The work done consisted of 8,250 square feet of mattress protection placed and sunk below low water, and 63,500 square feet of upper bank protection, stone, was placed in position. The amount expended was $4,391.59.

Pulltight.—At this locality the repairs which were in progress at the close of the last fiscal year were continued and completed, and the hurdles strengthened where necessary. A large quantity of drift which had accumulated above the upper hurdle was utilized as a foot mat or protection by sinking it, building a brush mattress on the drift to receive the stone necessary for the purpose. The effect of this work has been very beneficial by concentrating and straightening the channel at this locality; 1,260 linear feet of hurdle was built and $30,806.87 expended during the fiscal year.

Jim Smith's.—At this locality hurdles and bank protection were repaired and extended. The object of the hurdle extension was to close the channel passing to the left or Illinois side of the middle bar, concentrating the flow on the west; 2,940 linear feet of hurdle was completed and 1,390 linear feet of bank protection, consisting of willow-mattress and stone placed in position; $31,359.81 was expended during the fiscal year.

Lucas'.—At this locality the work consisted in the repair of small gaps in the hurdles of last year and in the construction of two additional hurdles, Nos. 5 and 6; 4,050 linear feet of hurdle was completed in this locality in addition to the repairs above mentioned. The work at this locality was projected and begun in March, 1889, and has continued since. The object was to concentrate the water at Lucas' Crossing and close the false channel behind Calico Island. The work has been of great benefit to navigation, straightening and deepening the channel at this crossing; $60,629.05 was expended during the fiscal year.

Surveys.—During the year the survey of the river was continued to Brickey's Mill, a distance of 48 miles from the St. Louis Bridge, and a hydrographic survey of the river from the mouth of River Des Peres to foot of Calico Island made to show the changes in the channel and the effects of the improvements. The expenditure for surveys was $7,016.89.

A reference to the plates accompanying the report of the officer in charge will give a graphic representation of the progress and effect of these works.

The amount expended during the year was $129,268.78, and the total amount expended to June 30, 1890, was $4,034,422.29.

The original estimated cost of the work, as revised in 1883, was $16,997.100.

July 1, 1889, amount available		$171,342.34
July 1, 1890, amount expended during fiscal year exclusive of liabilities outstanding July 1, 1889	$77,033.86	
July 1, 1890, outstanding liabilities	52.42	
		77,086.28
July 1, 1890, balance available		94,256.06
Amount appropriated by act of September 19, 1890		400,000.00
Amount available for fiscal year ending June 30, 1891		494,256.06
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		12,557,500.00

(See Appendix Y 2.)

3. *Gasconade River, Missouri.*—This river was greatly obstructed by snags, logs, and leaning timber, which materially interfered with navigation. Work was commenced on this stream in 1880, and the project adopted for its improvement consisted in the removal of snags and logs, the cutting of leaning timber, and the construction of contraction works at shoal crossings.

The amount expended to June 30, 1889, was $39,936.09, and at that time the navigation was much improved by the work done. During the fiscal year ending June 30, 1890, $2,130.26 was expended in removing obstructions from the bed of the river and cutting down leaning timber from the banks, also in constructing wing-dams and training-walls, thereby greatly improving the navigation of the river and enabling boats to run at lower stages of water than formerly.

The original estimate for the improvement of this stream was $50,000. New obstructions are continually forming, and it will require a small amount each year to keep the channel open at low water after the principal work has been done.

July 1, 1889, amount available		$2,563.91
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$2,135.34	
July 1, 1890, outstanding liabilities	.92	
		2,136.26
July 1, 1890, balance available		427.65
Amount appropriated by act of September 19, 1890		4,000.00
Amount available for fiscal year ending June 30, 1891		4,427.65

(See Appendix Y 3.)

4. *Osage River, Missouri.*—The navigation of this stream was very much interfered with by obstructions in the channel and shoal crossings. The original project, adopted in 1871, was to obtain a low-water

navigation of 2 feet, by means of dams and training walls, but this w abandoned, and a new project, consisting in the removal of snags a logs, cutting of leaning timber, and constructing dams and trainii walls at shoal crossings, was adopted.

The amount expended to June 30, 1889, was $200,093.04, at wh time the navigation was in a fair condition, the worst obstructi having been removed. During the fiscal year ending June 30, 18 $2,364.56 was expended in removing obstructions from 42 miles of river. Three rack heaps and 12 snags were removed and 10 trees fell This greatly improved the navigation over the lower 60 miles of river, besides rendering it much safer than formerly.

No estimate was made for the improvement of this stream under second project. An annual appropriation is, however, required to k this stream in navigable condition by the removal of obstructions t are brought down during the floods.

July 1, 1889, amount available		$4,505
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$1,973.81	
July 1, 1890, outstanding liabilities	.25	
		1,974
July 1, 1890, balance available		2,531
Amount appropriated by act of September 19, 1890		55,000
Amount available for fiscal year ending June 30, 1891		57,531

(See Appendix Y 4.)

SURVEY TO COMPLY WITH THE REQUIREMENTS OF THE RIVER A HARBOR ACT OF AUGUST 11, 1888.

The river and harbor act of August 11, 1888, contains the followi

The Secretary of War is hereby authorized and directed to caus survey to be made of the Osage River, Missouri, from its mouth up the first shoal, and 5 miles above the same, and to report an estima based on such survey, of the cost of constructing one lock and dam wit the limits of said survey, and the effect upon the navigation of s river of constructing said lock and dam.

The local engineer, Major Miller, was charged with and complet this survey, the results of which were transmitted to Congress a printed as House Ex. Doc. 119, Fifty-first Congress, first session. (also Appendix Y 5.)

IMPROVEMENT OF THE MISSISSIPPI RIVER BETWEEN THE DES MOIN RAPIDS AND THE MOUTH OF THE ILLINOIS RIVER.

Officer in charge, Maj. E. H. Ruffner, Corps of Engineers; Divisi Engineer, Col. O. M. Poe, Corps of Engineers.

The general project consists in contracting the low-water bed of t river to an average width of 1,800 feet. All island chutes are to closed by dams, and the river is to be contracted by wing-dams wh it is wider than the proposed low-water bed. The works are genera built of rock and brush. Piling is occasionally used. At times the lo water channel is deepened by dredging. Work under the present app priation was done at Smoot Chute, Whitney's Bar, Beebee Island, a Mason's Island. Dredging in Quincy Bay and at Whipple Creek B in Quincy Bay, as required by the appropriation, were the princi operations.

July 1, 1889, amount available		$110,114.00
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$84,972.00	
July 1, 1890, outstanding liabilities	1,934.51	
		86,906.51
July 1, 1890, balance available		23,207.49
Amount appropriated by act of September 19, 1890		165,000.00
Amount available for fiscal year ending June 30, 1891		188,207.49
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		Unknown.

(See Appendix Z 1.)

IMPROVEMENT OF THE NAVIGATION OF THE MISSISSIPPI RIVER BETWEEN MINNEAPOLIS AND DES MOINES RAPIDS, INCLUDING IMPROVEMENTS AT SPECIAL LOCALITIES BETWEEN THOSE POINTS—OPERATING AND CARE OF DES MOINES RAPIDS CANAL.

Officer in charge, Maj. A. Mackenzie, Corps of Engineers; Division Engineer, Col. O. M. Poe, Corps of Engineers.

1. *Operations of snag-boats and dredge-boats on Upper Mississippi River.*—At the beginning of the fiscal year there was available under act of August 11, 1888, the sum of $25,000.

From July to November, 1889, and during April, May, and June, 1890, the snag-boat *General Barnard* was employed removing snags and other obstructions and assisting interests of navigation between Minneapolis and the mouth of the Missouri River.

During a part of July and August, 1889, the snag-boat *J. G. Parke* and dredge *Phœnix* were employed in deepening the channel at Beef Slough Bar.

In May and June, 1890, the *Phœnix*, tended by steam-launch *Ada*, and towed from point to point by snag-boat *General Barnard*, was engaged in removing wrecks in vicinity of St. Paul, La Crosse, Genoa, and Dubuque. During the same period she was also for a time employed in furnishing gravel for dam repairs at Harper Slough.

The total amount expended for snag-boat service on the Upper Mississippi River between Minneapolis and the mouth of the Missouri River to June 30, 1889, is $549,640.

There have been expended during fiscal year ending June 30, 1890, $25,000.

By the river and harbor act of August 11, 1888, provision was made for operating snag-boats and dredge-boats on the Upper Mississippi River under an indefinite appropriation, the sum so expended not to exceed the amount appropriated in said act for such purpose. The clause of the act regulating the annual expenditure for snag-boats and dredge-boats on the Upper Mississippi River is as follows: "For operating snag-boats and dredge-boats on Upper Mississippi River, twenty-five thousand dollars."

The total amount of freight transported on the Upper Mississippi River during the calendar year 1889 was, approximately, 3,000,000 tons.

June 30, 1890, amount drawn from Treasury under permanent appropriation	$25,000.00
June 30, 1890, amount expended during fiscal year	25,000.00
July 1, 1890, amount available, under permanent appropriation of August 11, 1888, for fiscal year ending June 30, 1891	25,000.00

(See Appendix A A 1.)

2. *Mississippi River from Minneapolis to Des Moines Rapids.*—Prior to August 11, 1888, this work was carried on under appropriation for "improving Mississippi River from St. Paul to Des Moines Rapids." The act of August 11, 1888, extended the upper limits of the district from St. Paul to Washington Avenue Bridge, Minneapolis.

Under this appropriation is carried on the improvement of through navigation. Work has been in progress under approved projects since 1878, and very favorable results have been secured, showing that with a continuance of the work under liberal appropriations the low-water channel of the Mississippi between St. Paul and the Des Moines Rapids can be made comparatively safe, convenient, and permanent. The interests for which the improvement is being made are very large and important. The amount of freight carried during 1889, including the logs and lumber floated in the river, aggregated approximately 3,000,000 tons.

The original condition of the channel between the Des Moines Rapids and St. Paul was such that in low stages the larger boats were unable to proceed farther up the river than La Crosse or Winona; and in many seasons, at points much farther down, their progress was checked or seriously interfered with. In all such cases through freight was reshipped on small and light draft boats or barges. The originally adopted project for the improvement which has not been materially changed proposed the contraction of the channel or water-way by means of wing and closing dams to such an extent as, by means of the scour thereby caused, to afford a channel of sufficient width, and of a depth of 4½ feet at low water, to be eventually increased to six feet. There was expended on the permanent improvement of through navigation to June 30, 1889, the sum of $1,701,775.28, or $3,235 per mile. At that date and for several years previous the condition of the channel was such as to permit the passage of the largest boats at the lowest stages through to St. Paul.

During the past year work has been carried on by days' labor and use of Government plant between St. Paul and Lake Pepin, in vicinity of Winona, at Dresbach Bar, Crooked Slough, Bunker Chute, Rock Island Rapids, and in vicinity of Burlington and Pontoosuc; by contract between Read's Landing and Fountain City, between Fairport and Muscatine, in vicinity of Keithsburgh and Fort Madison; and by informal agreement at Bellevue. Temporary work in deepening channels by dredging was performed at several points. The work of the year has resulted in increased width and depth of channel at all the points mentioned above, notably in the stretch between St. Paul and Lake Pepin, at Winona, Dresbach, and Pontoosuc.

July 1, 1889, amount available		$362,841.04
Received from sale of fuel		3.00
		362,844.04
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$298,647.80	
July 1, 1890, outstanding liabilities	248.40	
		298,896.20
July 1, 1890, balance available		63,947.84
Amount appropriated by act of September 19, 1890		500,000.00
Amount available for fiscal year ending June 30, 1891		563,947.84

(See Appendix A A 2.)

3. *Des Moines Rapids, Mississippi River.*—This work was commenced in 1866. The adopted plan provided for the building of a closed canal 8 miles long and for cutting an open channel in the rock bed of the

river over the remaining 4 miles of rapids. The canal was opened in August, 1877, though not fully completed, and has been in operation since that time.

During the past year the raising of the lock-walls at lower lock, the office building at lower lock, the sluice in canal bank at Lamallee's Creek and a portion of the outside slope protection were completed. The lock grounds at lower lock were also raised and improved. The work remaining to be done to complete the improved project is the completion of the sluice at Price's Creek, the raising of the middle lock-walls, the removal of a small amount of rock above grade in the open channel, and the completion of the canal bank protection.

The net cost to the United States has been to June 30, 1889, $4,518,034.57.

July 1, 1889, amount available	$20,327.25
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	19,979.11
July 1, 1890, balance available	348.14
Amount appropriated by act of September 19, 1890	22,000.00
Amount available for fiscal year ending June 30, 1891	22,348.14

(See Appendix A A 3.)

4. *Operating and care of Des Moines Rapids Canal.*—During the past year the Des Moines Rapids Canal was open for navigation 239 days, during which time there passed through it 924 steam-boats and 477 barges, carrying 14,529 passengers, 71,453 tons of merchandise, and 397,788 bushels of grain. There also passed through 146,078,329 feet B. M. of lumber, 26,689,300 feet of logs, 73,540,370 shingles, and 44,316,167 lath. The expenses of the year have been $43,995.80 and the estimates for the coming year amount to $45,000.

The cost of operating and care of the canal are provided for by an indefinite appropriation made by act of March 3, 1881.

July 1, 1889, balance on hand	$1,162.03
June 30, 1890, amount drawn from Treasury under indefinite appropriation	43,837.97
	45,000.00
June 30, 1890, amount expended during fiscal year	43,995.80
June 30, 1890, balance on hand	1,004.20

(See Appendix A A 4.)

5. *Dry-dock at the Des Moines Rapids Canal, Mississippi River.*—The approved project for this work provided for the construction, near the middle lock of the canal, of a dry-dock 400 feet long and 100 feet wide, with gates of 80 feet opening, at an estimated cost of $125,000. This amount of money has been appropriated by Congress and the work has been completed in accordance with the project. The large plant owned by the United States and the entire commerce of the Upper Mississippi River will be benefited by this improvement.

The dry-dock will hereafter be operated as a part of the Des Moines Rapids Canal.

July 1, 1889, amount available	$2,007.45
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	2,007.45

(See Appendix A A 5.)

6. *Harbor of refuge on Lake Pepin, at Stockholm, Wisconsin.*—During the year the small amount of money available was expended in making

some needed repairs. The amount expended on this work, completed in accordance with modified project, is $25,000. A final report is submitted.

July 1, 1889, amount available	$139.47
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	139.47

(See Appendix A A 6.)

IMPROVEMENT OF THE MISSISSIPPI RIVER ABOVE THE FALLS OF ST. ANTHONY—IMPROVEMENT OF CHIPPEWA AND ST. CROIX RIVERS, WISCONSIN; OF MINNESOTA RIVER, MINNESOTA, AND OF RED RIVER OF THE NORTH, MINNESOTA AND DAKOTA—RESERVOIRS AT THE SOURCES OF THE MISSISSIPPI—IMPROVEMENT OF YELLOWSTONE RIVER, MONTANA AND DAKOTA—GAUGING MISSISSIPPI RIVER AT OR NEAR ST. PAUL.

Officer in charge, Maj. William A. Jones, Corps of Engineers, since November 15, 1889, having under his immediate orders since that date Lieut. William E. Craighill, Corps of Engineers; Division Engineer, Col. O. M. Poe, Corps of Engineers. These works were in charge of Maj. Charles J. Allen, Corps of Engineers, until November 15, 1889, with Lieut. William E. Craighill, Corps of Engineers, under his immediate orders.

1. *Mississippi River above Falls of St. Anthony, Minnesota.*—The present project, adopted in 1880, consists in improvement of the river between Aitken and Grand Rapids, a distance of 130½ miles, by removal of snags, bowlders, bars, and leaning trees from the channels, and construction of wing-dams, when necessary, to afford 3 feet depth during low-water stage, the cost being estimated at $54,127. In 1889 the estimate was increased to $63,000. Under the appropriations of 1880, 1881, and 1882, the river between the points named was well cleared of large numbers of obstructions. But between 1884 and 1888, and during the flood of the latter year, large numbers of snags and overhanging trees were formed. The appropriation, $10,000, by the act of August 11, 1888, was applied to removal of obstructions between Grand Rapids and a point about half-way to Aitken, and in addition a number of bowlders were removed to within 20 miles of the latter point.

Total expended to June 30, 1890, including outstanding liabilities, $44,960.13.

Total expended during the fiscal year ending June 30, 1890, $1,295.63.

Before improvement commenced in 1880 the stream between Aitken and Grand Rapids was so obstructed that navigation was difficult and at times almost impossible for steamers of lightest draught. There is now a general depth in the improved channels of 3 feet at low water, but there are many snags, leaning trees, bowlders, and masses of gravel yet remaining to be removed, as they contract the channels and thus interfere with the movement of steamers at any stage of water.

For a number of years previous to the present season several steamers have navigated this portion of the Mississippi, carrying passengers and freight to the settlements and supplies for lumber camps.

The opening last winter of the Duluth and Winnipeg Railroad from Duluth to the Mississippi River, 3 miles below Grand Rapids, has resulted in one steam-boat being withdrawn from the freight and passenger business. The remaining boat, the steamer *Fawn*, has continued to run from Aitken in connection with the Northern Pacific Railroad,

July 1, 1889, amount available, including that for outstanding liabilities ($3.67)		$1,339.17
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$1,295.63	
July 1, 1890, outstanding liabilities	3.67	
		1,299.30
July 1, 1890, balance available		39.87
Amount appropriated by act of September 19, 1890		18,000.00
Amount available for fiscal year ending June 30, 1891		18,039.87

(See Appendix B B 1.)

2. *Reservoirs at headwaters of Mississippi River.*—The object of the reservoirs is to collect surplus water, principally from the precipitation of winter, spring, and early summer, to be systematically released so as to benefit navigation upon the Mississippi River below the dams. The reservoir project is the outcome of surveys and examinations made in 1869, 1874, 1878, and 1879. From the results of these examinations and further examinations made in 1880, the first cost of constructing reservoir dams in Minnesota and Wisconsin was placed at $1,809,083. The cost of land and other damages to result from construction and operation of the proposed dams was not included in that estimate, as they could not be predicted with any approach to accuracy.

The present project consists in constructing reservoir dams at the headwaters of the Mississippi River in Minnesota, that locality having been selected for commencing the work in consequence of an appropriation made by the river and harbor act approved June 14, 1880, for construction of a reservoir dam at Lake Winnibigoshish, Minnesota, and for other reasons given in Appendix Y to the Annual Report for 1886. By 1886 four of the reservoirs had been created.

During the past fiscal year the end cribs and connections between the timber and earth work at Lake Winnibigoshish Dam were strengthened. At Leech Lake Dam a weighting of stone was added to the superstructure.

The reservoirs were operated, 1885–1889, during the seasons of low water, to the benefit of navigation on more than 165 miles of the Mississippi River, viz: Between Grand Rapids and Aitken, 130½ miles, and from St Paul to some distance below the confluence of the Mississippi and St. Croix rivers.

Expended during the fiscal year ending June 30, 1890, including outstanding liabilities, $12,513.10.

Total expended upon this work to the close of the fiscal year ending June 30, 1890, including examinations at proposed dam-sites, land damages, amounts set aside as awards to Indians, and care and maintenance of the works, $623,986.63.

July 1, 1889, amount available		$23,026.47
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$11,227.13	
July 1, 1890, outstanding liabilities	1,285.97	
		12,513.10
July 1, 1890, balance available		10,513.37
Amount appropriated by act of September 19, 1890		80,000.00
Amount available for fiscal year ending June 30, 1891		90,513.37
Amount (estimated) required for completion of existing project. Submitted in compliance with requirement of sections 2 of river and harbor acts of 1866 and 1867.		1,094,583.50

(See Appendix B B 2.)

3. *Chippewa River, including Yellow Banks, Wisconsin.*—The plan for improvement of the Chippewa River consists in revetment of caving bends and construction of dams and jetties from Eau Claire to the confluence of the Chippewa and Mississippi, a distance of 57 miles, to confine the low-water volume to a channel of nearly uniform width and depth. The general plan was adopted in 1877, and the work has been carried on in accordance with it, varying, however, more or less, as to location and extent of dams, jetties, etc. The protection of the Yellow Banks consists in a revetment of piling and fascines, the latter to be crowned with rock. The object of the Yellow Banks protection is to prevent their erosion, and thus to relieve the channels of the Chippewa River and of the Mississippi below the junction of the two streams from the masses of sand contributed by those banks. The plan for protecting the banks was adopted in 1883. The improvement of the river and the protection of the Yellow Banks were regarded as separate and distinct works until the act of August 11, 1888. Estimated cost of the consolidated improvement, including all expenses from the commencement, $272,487.72.

Before the improvement commenced the depth on the bars at low water seldom exceeded 18 inches, and the crossing at the mouth of the river was extremely difficult at that stage, owing to the volume of the river joining the Mississippi through a number of channels of insufficient depth. These latter-named channels were contracted into one of good depth by means of long parallel jetties. Generally, wherever works for improvement were constructed by the Government, the low-water depths were increased from 18 inches to 3 to 4 feet. And the general improvement not only greatly facilitated the passage of steamers and rafts, but also greatly reduced the expense of rafting manufactured lumber.

Expended during the fiscal year ending June 30, 1890, including outstanding liabilities, $1,713.32.

Total expended from commencement of operations in 1877 to June 30, 1890, including outstanding liabilities, $156,048.25.

Owing to lack of funds, the work for the year was confined to care of plant and the repairs to jetties at mouth of river.

July 1, 1889, amount available		$2,415.07
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$1,510.72	
July 1, 1890, outstanding liabilities	202.60	
		1,713.32
July 1, 1890, balance available		701.75
Amount appropriated by act of September 19, 1890		10,000.00
Amount available for fiscal year ending June 30, 1891		10,701.75
Amount (estimated) required for completion of existing project Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867		105,737.72

(See Appendix B B 3.)

4. *St. Croix River, Wisconsin and Minnesota.*—The original project for improvement, adopted in 1878, was based upon a survey made in 1874 when the river was at a high stage of water and but comparatively few obstructions to be seen. It contemplated removal of snags, bowlders, sand-bars, etc., and contraction of the low-water channels from Taylor's Falls to the confluence of the river with the Mississippi into one of nearly uniform width. Estimated cost, $21,758. At low water, however, the channel had in many places but 2 feet of depth,

and steamers and barges made their way as best they could amongst the obstructions; at times it was impossible for them to get over the shoal places. The present project, adopted in 1880, and modified as to cost in 1882 and again in 1889, is based upon a low-water survey made in 1879, and differs from that originally adopted only in amount of work to be done. Estimated cost, $108,700.

Expended during the fiscal year ending June 30, 1890, including outstanding liabilities, $359.19.

Expended under present project to June 30, 1890, including outstanding liabilities, 74,455.94.

Total expended under original and present projects to June 30, 1890, including outstanding liabilities, 92,455.94.

The appropriation having been practically exhausted previous to June 30, 1889, there are no active operations to report during the past fiscal year. The small balance on hand was used in caring for and maintaining plant.

The effect of the work of improvement has been to secure a least depth of 3 feet on the improved bars above Stillwater, and 4 to 5 feet on the bars below that place. Generally, it may be said of this improvement that at many points navigation has been rendered permanent where formerly it was uncertain, and that in other places it has been made practicable, where, before improvement, it was impossible.

July 1, 1889, amount available		$403.25
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	337.56	
July 1, 1890, outstanding liabilities	21.63	
		359.19
July 1, 1890, balance available		44.06
Amount appropriated by act of September 19, 1890		8,000.00
Amount available for fiscal year ending June 30, 1891		8,044.06
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		26,200.00

(See Appendix B B 4.)

5. *Minnesota River, Minnesota.*—From 1867 to 1873, inclusive, Congress appropriated $77,500 for improving the Minnesota River. The appropriations were applied to removing snags and bowlders, so as to afford a least depth at low-water stage of 2 to 3 feet. In 1874 a survey was made from the mouth of the river to South Bend, a distance of about 116 miles, to determine the practicability of improving the navigation by means of canals, locks, and dams. Based upon this survey, estimates were made for five locks and dams and removal of snags, etc., at a cost of $733,868.63, the cost of removing snags, etc., being therein placed at $34,585.10, including contingencies. Following this report, Congress made three appropriations of $10,000 each, by acts approved March 3, 1875, August 14, 1876, and June 18, 1878, which sums were applied to clearing the river of obstructions below South Bend.

Expended to June 30, 1879, $117,457.

Since 1879 no work for improvement of the river has been undertaken. Under the appropriations above named the removal of obstructions cleared the way over long stretches of the river between Minnesota Falls and a point about 30 miles below Henderson (16.7 miles above Shakopee). Little or no use was made of the cleared channels, as there was not sufficient depth of water in the channel to permit navigation during the low-water periods. *The rapidly caving* banks on the upper

section of this stream cause snags and leaning trees to form, so that channels which were cleared of them eleven years ago are more or less encumbered with them to-day.

No expenditures have been made for the improvement of the lower part of the river, which offers much better facilities for river traffic than the upper part. From Shakopee to the Mississippi the river is deep, except on two bars. There are few snags on this reach.

The river and harbor act of August 11, 1888, appropriated $10,000 for improving the Minnesota River, including protection of the banks opposite the borough of Belle Plaine. It appearing from an examination made in September, 1888, that the sum was inadequate for the purposes named, its expenditure for work for improvement was deferred until the further wishes of Congress in the matter might be known, or until some definite information as to prospective navigation might be obtained upon which to base a project for the best utilization of the appropriation.

Total expended on the improvement of the whole river to the close of the fiscal year ending June 30, 1890, $117,532.

Expended during the year ending June 30, 1890, $56.40.

July 1, 1889, amount available, including that for outstanding liabilities ($9.00)		$10,023.40
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$56.40	
July 1, 1890, outstanding liabilities	9.00	
		65.40
July 1, 1890, balance available		9,958.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		693,868.63

(See Appendix B B 5.)

6. *Red River of the North, Minnesota and Dakota.*—The project for the improvement of this river from Breckenridge to the northern boundary line, adopted in 1877, and amended as to cost in 1883, consists in the removal of snags, leaning trees, and bowlders, and in dredging channels through the bars, at an estimated cost of $179,310. A revised estimate made in 1887 placed the cost of completing the improvement at $79,598.37.

The work during the past fiscal year has, on account of extreme low water, been confined to two and one-half months' dredging north of Grand Forks and to needed repairs to the boats.

Before improvement the ruling depth upon bars between Moorhead and Goose Rapids, at ordinary low water, was but 1½ feet, and below Grand Forks 2 feet, while between Moorhead and Abercrombie the navigation was at all times difficult.

The work to June 30, 1890, has resulted in opening a channel 3 feet deep at ordinary low water and 60 feet wide from Moorhead to a point 80 miles north, and a channel 4 feet deep at ordinary low water and about 70 feet wide from Grand Forks to a point 62 miles north by river; also in the removal of snags and trees between Moorhead and Abercrombie so as to afford safe passage for steamers between those points during high and medium stages of water.

Amount expended during the fiscal year ending June 30, 1890, including outstanding liabilities, $13,277.71.

Total amount expended, including outstanding liabilities, to June 30, 1890, $187,042.79.

July 1, 1889, amount available		$16,182.57
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$11,412.09	
July 1, 1890, outstanding liabilities	1,865.62	
		13,277.71
July 1, 1890, balance available		2,904.86
Amount appropriated by act of September 19, 1890		25,000.00
Amount available for fiscal year ending June 30, 1891		27,904.86

Amount (estimated) required for completion of existing project 34,598.37
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix B B 6.)

7. *Surveys for reservoirs at the sources of the Mississippi, St. Croix, Chippewa, and Wisconsin Rivers.*—Nothing was done under this head during the past fiscal year, no funds having been available for such work.

Amount (estimated) required for completion of existing project $50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix B B 7.)

8. *Yellowstone River, Montana and Dakota.*—The project for improvement is to work down the river from Glendive, building wing dams and dams to close island chutes where necessary in order to confine the water generally to one channel, and to thereby increase the depth on the rapids and shoal places; also, to remove rocks and bowlders from the channels.

The original condition of the navigable channel was bad and unsafe, due to the existence of numerous swift rapids, to crooked and shallow channel at low water, and to the presence of rocks and loose bowlders. By removing the latter at the worst places and by confining the water to one channel so as to increase the depth on the rapids, the river has been considerably improved for purposes of navigation. No work other than repairs to and care of the plant has been done since 1885. At present the stream is not navigated by steamers.

Expended to the close of the fiscal year ending June 30, 1890, $106,823.55.

Expended during the fiscal year ending June 30, 1890, including outstanding liabilities, $15.26.

July 1, 1889, amount available	$11,941.71
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	15.26
July 1, 1890, balance available	11,926.45

Amount (estimated) required for completion of existing project 106,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix B B 8.)

9. *Gauging Mississippi River at or near Saint Paul, Minnesota.*—The Board of Engineers, to whom was referred the project for the application of $37,500 appropriated by the river and harbor act of August 5, 1886, for reservoirs at the headwaters of the Mississippi River, recommended in their report dated May 24, 1887, "that such gaugings be made at or near St. Paul during the annual operation of the reservoirs

as shall determine accurately the discharge at that point at critical periods." (Page 1692, Annual Report Chief of Engineers, 1887.)

The river and harbor act of August 11, 1888, authorized the gaugings and provided for them as follows:

"And the Secretary of War shall cause such gaugings to be made at or near St. Paul during the annual operation of said reservoirs as shall determine accurately the discharge at that point, the cost of the same to be paid out of the annual appropriation for gauging the waters of the Mississippi River and its tributaries."

* * * * * * *

"SEC. 6. That for the purpose of securing the uninterrupted gauging of the waters of the Lower Mississippi River and its tributaries, as provided for in joint resolution of the twenty-first of February, eighteen hundred and seventy-one, upon the application of the Chief of Engineers, the Secretary of War is hereby authorized to draw his warrant or requisition from time to time upon the Secretary of the Treasury for such sums as may be necessary to do such work, not to exceed in the aggregate for each year the amount appropriated in this act for such purpose: *Provided, however,* That an itemized statement of said expenses shall accompany the Annual Report of the Chief of Engineers."

Gaugings were not made until the fall of 1889, although an allotment of $900 for the fiscal year ending June 30, 1889, had been made. On account of the lateness in the season and the condition of the river, it was not deemed advisable to expend any of the money that year.

The allotment of $600 made August 23, 1889, for the fiscal year ending June 30, 1890, was applied to gauging the Mississippi River at St. Paul, and when necessary the Minnesota River at its mouth. There were in all 45 gaugings made during the months of September and October, 1889, and February and March, 1890.

The limited record of the volume of the Mississippi River at St. Paul during the past year has been an addition to the data on hand for determining the effect of the operation of the reservoirs. To be of great value, however, the allotment of funds for this work should be large enough to provide a continuous daily record of the discharge of the Mississippi River at and near St. Paul for a long period of time.

Amount expended during the fiscal year ending June 30, 1890, $600.

Total amount expended to June 30, 1890, $600.

Amount allotted August 23, 1889	$600.00
July 1, 1890, amount expended during fiscal, exclusive of liabilities outstanding July 1, 1889	600.00

(See Appendix B B 9.)

IMPROVEMENT OF TENNESSEE AND CUMBERLAND RIVERS, AND OF CERTAIN RIVERS IN EASTERN TENNESSEE AND KENTUCKY.

Officer in charge, Lieut. Col. J. W. Barlow, Corps of Engineers, with Lieut. H. E. Waterman, Corps of Engineers, under his immediate orders, until October 6, 1889, and with Lieut. George W. Goethals, Corps of Engineers, under his immediate orders since October 23, 1889.

1. *Tennessee River.*—(*a*) *Above Chattanooga.*—This section of the river, 194 miles, is navigable for light-draught boats to the mouth of the French Broad River for the greater part of the year.

The river above Chattanooga, by examinations made in 1830, was found to be obstructed by rock-reefs, sand and gravel-bars, and surface obstructions. The banks are of such a character as to make any improvement practically permanent, with the exception of the removal, from time to time, of such snags and drift as may be brought down by the yearly freshets.

The present project is to blast a channel through reefs and to deepen

water on the bars by the use of wing-dams so as to obtain at average low water a navigable channel of 3 feet in depth.

The amount expended to June 30, 1889, was $231,038.46. The expenditure of this sum has resulted in a lengthened season of navigation for steamboats, and a safer channel for the passage of rafts and flat-boats, which make up the greater part of the commerce of this portion of the river. This work has been confined to twenty-nine of the forty-three obstructions enumerated as interfering with navigation on the Upper Tennessee. Also a snag and tow-boat was built in 1888, for use upon the Tennessee and its tributaries, payment for which forming a part, pro rata, of the above expenditures. In August last the fleet was moved down from the French Broad River and commenced operations at White Creek Shoals, excavating the channel, lengthening the longitudinal dam, and removing drift, snags, and overhanging trees.

The amount expended during the fiscal year, including outstanding indebtedness, was $6,214.34.

July 1, 1889, amount available		$9,961.54
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$5,642.10	
July 1, 1890, outstanding liabilities	572.24	
		6,214.34
July 1, 1890, balance available		3,747.20
Amount appropriated by act of September 19, 1890		30,000.00
Amount available for fiscal year ending June 30, 1891		33,747.20
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		29,000.00

(See Appendix C C 1.)

(*b*) *Below Chattanooga.*—This section of the river,—extending from Chattanooga, Tenn., to Paducah, Ky.,—a distance of 456 miles, though partially obstructed by reefs and bars, is navigable for the greater part of the year, with the exception of the 39 miles rendered impassable by the Muscle Shoals.

The present project for improvement comprises the building of a canal at Big Muscle Shoals 14½ miles long, 70 to 120 feet wide, and giving a depth of 6 feet of water; having 9 locks, each 300 feet between miter sills and 60 feet wide, and an aqueduct across Shoal Creek 900 feet long and 60 feet wide and 5 feet deep. The construction of a canal around Elk River Shoals, containing two locks of the same dimensions as those of the Big Muscle Shoals, and two sections of heavy channel improvement, one section at the head of Elk River Shoals, the other at Little Muscle Shoals; also the improvement, by the use of wing-dams, of the obstructions on the remaining portions of the river above Decatur and below Florence.

The total expenditure to June 30, 1889, was $3,064,110.51, and has resulted in the improvement of the river as follows:

At Little Muscle Shoals, the channel excavation for 2½ miles was practically completed, as modified, and a system of wing-dams, fourteen in number, built at a cost for the whole work of $126,180. The results as obtained are by no means satisfactory, and, as soon as the stage of water permitted, a survey on which to base estimates for a canal was made in June, 1890.

At Big Muscle Shoals and Elk River Shoals, the eleven locks were completed and are in working order.

The Shoal Creek Aqueduct was completed and tested. The canal trunk was widened and retaining-walls strengthened. Permanent dams and bridges were constructed at Second Creek, Bluewater Creek, Hell Town Branch, Douglass Branch, Four Mile Creek, and Six Mile Creek, and various retaining-walls built across small ravines along the system. Three waste-weirs and three drift-sluices were constructed at the head of Locks 2, 4, and 6, respectively, and have proved of great service. The dredge *Harwood* and two dump-scows were constructed for use on the river and canal trunk, and were employed in dredging below Lock "B," and other services.

The amount expended during the fiscal year, including outstanding liabilities, was $128,809.80, and has resulted as follows:

Two drift-sluices were completed at Locks 2 and 4, respectively.

The piers of the Bluewater Bridge were raised, and practically a new bridge constructed.

The Shoal Creek Aqueduct was painted and the bottom covered with a heavy coating of pitch.

A lock-keeper's stone and frame house was built at Lock No. 1, and the superintendent's house of brick, at Lock No. 6, commenced late in the year, is approaching completion.

The tow-path above Lock No. 6 was strengthened by the deposit of dredged material along the foot of the inner slope of the embankment, and by placing heavy blocks of riprap on the outer slope.

The retaining-wall below Lock No. 7 was strengthened by the addition of riprap in heavy blocks placed on the outside of the retaining-wall.

Leakage was prevented by the addition of a lining of clay along the embankment—a distance of about 2,500 feet.

A revetment along the north side of Lock No. 8 composed of iron, timber, and plank, was completed and a movable dam placed at the foot of Lock No. 9.

Temporary houses were built at Locks Nos. 1, 2, 4, 5, and 8.

At Lock A the hydraulic machinery for moving the gates and wickets was placed in position and tested. The walls and lower gates of the lock have been raised 40 inches, and a sluice-way constructed back of the lock.

The turbine, pumps, gate and wicket engines will be satisfactory with slight changes. The dam above the lock was elevated 2 feet for a considerable distance, and work begun on a drift-sluice in this dam having an automatic gate.

A telephone line 25 miles long was constructed, connecting the two divisions, and satisfactory connections made.

The dredge *Harwood* has been at work on both divisions excavating and widening channels, etc.

The Government boats have frequently been passed through the canal as far as Lock No. 6, and occasionally through the entire system.

The tug-boat *McFarland* was completed and has been in constant use at the lower division.

The United States snag-boat *Weitzel* was employed at the "Suck" on both divisions of the canal, at Little Muscle Shoals, and snagging and towing in various portions of the river.

Sites for lock-keepers' houses, repair shops, etc., have been selected at the several locks, and necessary action is being taken to purchase the same and procure cession of jurisdiction from the State of Alabama, the lands having already been purchased for these sites at Locks Nos. 2 and 6.

Plans have been made and material procured for timber fenders to be placed in Shoal Creek Aqueduct.

This work will soon be accomplished, and is necessary to prevent craft from striking and injuring the side plates.

The system of hydraulic machinery in use at the Lock A will be applied to other locks as soon as practicable, with some advantageous modifications.

Revised plans and estimates are under consideration by a Board of Engineer Officers, having in view the radical improvement of Colbert and Bee Tree shoals; the same Board will also consider and report upon a revised project for the improvement of Little Muscle Shoals.

The engineer officer in charge specially invites attention to the dangerous obstruction known as the "Suck," and also to the pressing need of an instrumental survey of the Lower Tennessee.

July 1, 1889, amount available		$143,889.49
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$108,388.19	
July 1, 1890, outstanding liabilities	20,421.61	
		128,809.80
July 1, 1890, balance available		15,079.69
Amount appropriated by act of September 19, 1890		475,000.00
Amount available for fiscal year ending June 30, 1891		490,079.69
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		1,373,000.00

(See Appendix C C 1.)

2. *French Broad River, Tennessee.*—Rising on the western slope of the Blue Ridge in North Carolina, this stream crosses the Tennessee line at Paint Rock, and after a further course of 121 miles joins the Holston 5 miles above Knoxville,—thus forming the Tennessee River.

By examinations made in 1871 and 1875, the river was found to be obstructed by rock-reefs, sand and gravel-bars, and surface obstructions, such as bowlders, snags, and overhanging trees. It was not deemed feasible to improve the river above Leadvale, but from this point to the mouth—a distance of about 90 miles—it is projected to remove all surface obstructions, and by excavation and the use of wing-dams to secure for this distance a channel depth of 2½ feet at ordinary low water. Above the mouth of Nolichuky River (Leadvale) to the boundary line of Tennessee and North Carolina, a system of locks and dams is the only feasible method of improvement, but the amount of commerce does not warrant the expenditure.

The amount expended to June 30, 1889, was $34,602.17, thereby securing an improvement of the principal obstructions, and a deepening of the channel from 6 to 10 inches, and in the removal of snags and overhanging trees.

During the fiscal year work was continued at Seven Island Shoals by building 1,523 cubic yards of crib and riprap dams, and excavating 1,433 cubic yards of rock and gravel, and removing 240 overhanging trees from the channel. Active operations were closed in September, 1889.

The amount expended during the year, including outstanding indebtedness, was $2,833.39.

July 1, 1889, amount available		$3
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$2,671.89	
July 1, 1890, outstanding liabilities	161.50	
		2
July 1, 1890, balance available		
Amount appropriated by act of September 19, 1890		1(
Amount available for fiscal year ending June 30, 1891		1(
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		10

(See Appendix C C 2.)

3. *Hiawassee River, Tennessee.*—This stream, after following a almost at right angles to the Tennessee, enters that river about 3 above Chattanooga.

It was found by an examination of the river made in 1875, was obstructed by rock-reefs, sand and gravel bars, and surfa structions.

The present project consists in the deepening of the channel cavation, and the construction of wing-dams so as to secure a n ble channel 40 feet wide and 2 feet deep at average low water, a up as Savannah Ford,—a distance of about 43 miles,—and the re of all snags, bowlders, overhanging trees, and other surface ol tions.

The amount expended to June 30, 1889, was $34,000, and l sulted in the clearing and improving of the channel of the lowe to a limited degree, the appropriations being too small to allow radical improvement.

The work of the fiscal year was confined to removing logs, snag overhanging trees from the channel of the lower river.

The amount expended during the fiscal year, including outst indebtedness, was $950.06.

July 1, 1889, amount available		
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$891.60	
July 1, 1890, outstanding liabilities	58.46	
July 1, 1890, balance available		
Amount appropriated by act of September 19, 1890		1
Amount available for fiscal year ending June 30, 1891		1

(See Appendix C C 3.)

4. *Clinch River, Tennessee.*—This stream rises in the Cumb Mountains in Virginia, and, after following a southwesterly cou about 400 miles, empties into the Tennessee River at Kingston, 110 miles above Chattanooga. About 230 miles of the river through the State of Tennessee.

An examination of this river was made in 1875, when the cl was found to be very crooked, and obstructed by sand and grave by rough rock-reefs, and the surface obstructions usually fou mountain streams. It is deemed feasible to improve about 145 m its course in Tennessee by channel excavation and wing-dams, a removal of such logs and overhanging trees, from time to time, a prove obstructions to navigation.

The present project looks to this improvement so far as to obt

average low water, a depth in the channel of 2 feet from the mouth of the river to Clinton—about 70 miles—and of 1½ feet from Clinton to Walker's Ferry (Haynes), a distance of about 75 miles.

The amount expended to June 30, 1889, was $30,163.07, which has resulted in keeping the river comparatively free from surface obstructions, and securing an improvement of the channel at many of the worst shoals in its course.

The amount expended during the last fiscal year, including outstanding indebtedness, was $836.93, and resulted in the extension and strengthening of the dams at Lew Allen Shoals; by building 60 feet of crib-dams, placing therein 528 cubic yards of stone; twenty-eight overhanging trees were also cut down.

July 1, 1889, amount available		$836.93
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$822.88	
July 1, 1890, outstanding liabilities	14.05	
		836.93
Amount appropriated by act of September 19, 1890		4,000.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		15,000.00

(See Appendix C C 4.)

5. *Cumberland River, Tennessee and Kentucky—(a) Below Nashville.*—The present project for improving this portion of the river is based on an examination made in 1871. The obstructions were found to be of the same general character throughout, consisting of rock-reefs, sand and gravel-bars, bowlders, snags, and overhanging trees and other surface obstructions. This project comprises the deepening of the channel by excavation and the use of wing-dams; the removal of snags and surface obstructions, and the opening of the channel in the Kentucky Chute of the Ohio, at and near the mouth of the Cumberland, by the building of a crib and brush-dam.

The total amount expended up to June 30, 1889, was $256,387.90, and has resulted in securing an improved channel over the worst shoals and thus securing a lengthened season of navigation. During the fiscal year $5,673.26 was expended, including outstanding indebtedness; the work being confined to snagging between Nashville and Ingram Shoals, and repairing dams at Palmyra Island, Dover Shoals, Gatlin Shoals, and Line Island Shoals. Payments for watching and caring for engineer property at Gatlin Shoals and contingent authorized expenses formed part of the above expenditures.

July 1, 1889, amount available		$8,612.10
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$5,370.55	
July 1, 1890, outstanding liabilities	302.71	
		5,673.26
July 1, 1890, balance available		2,938.84
Amount appropriated by act of September 19, 1890		40,000.00
Amount available for fiscal year ending June 30, 1891		42,938.84
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		193,000.00

(See Appendix C C 5.)

(*b*) *Above Nashville.*—The present project provides for the complete canalization of the river from above Smith's Shoals to Nashville, a distance of 377 miles. The project is based upon an instrumental survey made in 1883, the estimates as approved covering the construction of thirty locks and dams at an aggregate cost of $4,077,922.

Up to June 30, 1889, $69,563.41 had been expended, which sum was applied to open channel improvement and necessary expenditures contingent to the building of Lock No. 1 of the new project.

During the fiscal year the coffer-dam for construction of Lock No. 1 was completed; considerable excavation for the lock-pit was made and about two-thirds of the stone for the lock-walls, contracted for, was quarried and cut. Work was greatly retarded by continual high water.

Bids for the abutment of the dam at Lock No. 1 were opened August 9, 1889, but contract has not been awarded.

A snagging party worked down from Caney Fork River to Nashville clearing the channel of snags and drift, and cutting down overhanging trees.

The question of style of dam to be used at Lock No. 1 was submitted to a Board of Engineers constituted for the consideration of the subject. The Board was of the opinion that the prospect of success of the bear-trap dam designed by the engineer officer in charge was sufficient to justify its trial, but recommended that the final adoption be deferred until experiments could be made with the new dam at Davis Island, Ohio River.

Lands for sites for lock-keeper's house, etc., at Lock No. 2, were purchased and jurisdiction ceded to the United States.

The amount expended during the fiscal year, including outstanding liabilities, was $10,116.08.

The engineer officer in charge repeats his suggestion for the reasons given in his report that a lock and dam be constructed below Burnside, Ky., thus carrying on the work at each end of the canal system.

July 1, 1889, amount available		$198,892.72
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$7,814.14	
July 1, 1890, outstanding liabilities	2,301.94	
		10,116.08
July 1, 1890, balance available		188,776.64
Amount appropriated by act of September, 19, 1890		250,000.00
Amount available for fiscal year ending June 30, 1891		438,776.64
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		3,502,922.00

(See Appendix C C 5.)

6. *South Fork of Cumberland River, Kentucky.*—This stream empties into the Cumberland River near Burnside, Ky., about 325 miles above Nashville.

By an examination made in 1884 its upper waters were found to be so obstructed by immense sandstone bowlders as to render its improvement impracticable. For a distance of about 44 miles—from its mouth to Devil's Jumps—however, it was considered practicable to improve the channel by deepening the water on the sand and gravel bars by the use of wing-dams and the removal of surface obstructions.

The present project provides for this improvement to an extent that will allow of safe navigation for flat-boats and rafts at a 3-foot stage above low water.

The amount expended to June 30, 1889, was $11,968.94, which has resulted in obtaining safe navigation for rafts, etc., for a distance of 16 miles above its mouth. No expenditures were made during the fiscal year ending June 30, 1890.

July 1, 1889, amount avilable	$31.06
July 1, 1890, balance available	31.06
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	50,803.00

(See Appendix C C 6.)

7. *Caney Fork River, Tennessee.*—This stream, after a course of about 200 miles wholly in the State of Tennessee, empties into the Cumberland River at Carthage, Tenn., about 116 miles above Nashville. It is one of the most important branches of the Cumberland River.

Examinations were made in 1879 as high up as Sligo's Ford, about 72 miles, and in 1884 it was extended 20 miles farther, to Frank's Ferry, the head of navigation.

The present project consists in keeping the river below Frank's Ferry clear of drift and other surface obstructions and in building such wing-dams as will insure safe navigation for small steam-boats and flat-boats during the boating season. usually about 5 months in duration—from February to July.

The amount expended to June 30, 1889, was $20,457.67, which has resulted in keeping the channel clear of surface obstructions and considerably improving the worst shoals in the river below Sligo's Ford.

The work carried on during the fiscal year has resulted in the completion of the dam at Trousdale's Ferry and the extension and strengthening of the main dam at Chandler's Island Shoals. Considerable channel excavation was done at the latter obstruction and a number of overhanging trees cut down and snags removed.

The amount expended during the year, including outstanding indebtedness, was $1,984.32.

July 1, 1889, amount available		$2,042.33
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$1,965.32	
July 1, 1890, outstanding liabilities	19.00	
		1,984.32
July 1, 1890, balance available		58.01
Amount appropriated by act of September 19, 1890		2,500.00
Amount available for fiscal year ending June 30, 1891		2,558.01
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		20,228.00

(See Appendix C C 7.)

EXAMINATION AND SURVEY FOR IMPROVEMENT, TO COMPLY WITH REQUIREMENTS OF RIVER AND HARBOR ACT OF AUGUST 11, 1888.

It appearing from the preliminary examination made by the local engineer of *Lower Cumberland River, Tennessee, from Nashville to its mouth, to ascertain if necessary to establish locks and dams*, that the locality is worthy of improvement, and the public necessity therefor being apparent from the facts and reasons reported, which are concurred in by the Chief of Engineers, Lieutenant-Colonel Barlow was

charged with and completed its survey, the results of which were transmitted to Congress and printed as House Ex. Doc, 85, Fifty-first Congress, first session. (See also Appendix C C 8.)

IMPROVEMENT OF THE OHIO, MONONGAHELA, MUSKINGUM, AND ALLEGHENY RIVERS—OPERATING AND CARE OF DAVIS ISLAND LOCK AND DAM, OHIO RIVER; OF LOCKS AND DAMS NOS. 8 AND 9, MONONGAHELA RIVER, AND OF LOCKS AND DAMS ON THE MUSKINGUM RIVER, OHIO—PURCHASE OF LOCK AND DAM NO. 7, MONONGAHELA RIVER; CONSTRUCTION OF ICE-HARBOR AT MOUTH OF MUSKINGUM RIVER, OHIO, AND OF LOCK AND DAM AT HERR'S ISLAND, ALLEGHENY RIVER.

Officer in charge, Lieut. Col. William E. Merrill, Corps of Engineers, having under his immediate orders First Lieut. Cassius E. Gillette, Corps of Engineers, also First Lieut. G. W. Goethals, Corps of Engineers, from September 18 to October 22, 1889. This district was under the temporary charge of First Lieut. Lansing H. Beach, Corps of Engineers, to August 26, 1889, and of Maj. Daniel W. Lockwood, Corps of Engineers, from August 27, 1889, to September 17, 1889.

1. *Ohio River.*—The general method followed in improving the navigation of the Ohio River is to secure additional depth at islands and sandbars by the construction of low dams across unused passages, and by building guiding-dikes where the river is so wide and shoal as to make it necessary to confine the current to a smaller cross-section. A snagboat and two dredges, all of them having iron hulls, are owned by the United States, and find constant employment in taking out snags and wrecks and in dredging away gravel-bars which can not be otherwise removed.

The first appropriation for the improvement of the Ohio River was made in 1827, and the total sum thus far appropriated exclusively for this river is $5,056,479.25. In addition to these direct appropriations a portion of several combined appropriations for the Mississippi, Missouri, Ohio, and Arkansas rivers, aggregating $1,997,040.68, has been allotted to the Ohio.

The following is a summary of the work done during the fiscal year. It should be premised that all river work was greatly delayed by a season of unusual rain:

Drift-gap at Davis Island movable dam.—This structure has been completed, but owing to continuous high water it has not yet been thoroughly tested.

Dam between Davis and Neville islands.—This dam has been completed, but after completion the river made a cut through the gravel-bar at the lower end of the dam. This cut is under control, but the work of repair has not been concluded, having been stopped by high water.

Dam at head of Marietta Island.—This dam is about half finished. A rise that covered the work while in an unfinished condition made washouts around the ends of the dam, but they have been thoroughly stopped. About 150 feet of the unfinished middle section gave way in June.

Dike at Eight-Mile Island.—This work is finished except some stone filling and paving.

Dike at Bonanza Bar.—This work is finished except some stone filling and paving.

Dike at Madison, Indiana.—This work has been extended to about its full length, but the filling is yet incomplete.

Dike at Caseyville, Kentucky.—The piling of this dike has been driven for full length, but the interior filling is yet incomplete.

Dike at middle of Grand Chain.—This dike is about two-thirds done, but it was only extended about 200 feet during the year on account of continued high water.

Rock-bar at mouth of Licking River.—No excavation was made during the year on account of high water.

Rock reef at Brooklyn, Illinois.—This reef was removed to the shore-line.

Ice-pier at Pomeroy.—This pier of two sections was completed.

Ice-pier at Middleport.—This pier of two sections was completed.

Ice-pier at Gallipolis.—This pier of two sections was completed.

Ice-pier at Portsmouth.—This pier has three sections; the outer and middle sections are complete except sheathing, and the inner section is about one-fourth finished.

Great Miama embankment.—The extension of this embankment through the fair grounds has been completed.

Shawneetown embankment.—The work of raising and paving the embankment to the extent of the available funds has been completed.

Big Hocking River.—The contemplated work on this river has been completed, except building a small submersible dam and removing a few more rocks.

Dredging.—The Ohio River dredges worked during 1889 from June 13 to December 17. At Merriman Bar they excavated 12,249 cubic yards of loose rock and gravel; at Phillis Island they removed 1,925 cubic yards of cemented gravel; at Short Creek Bar they removed 35,489 cubic yards of loose rock and gravel, 101 tons of large rock, and 1 steam-boat hull; at the Steubenville Bridge over the Ohio they removed 3,522 cubic yards of cemented gravel; at Deep Run Bar they removed 1,549 cubic yards of loose rock and gravel; at the foot of Blenuerhassett's Island they removed 26,389 cubic yards of loose rock from the half-moon dike, 10,377 cubic yards of gravel and sand, and 11 logs; from the Little Kanawha River they removed 4,645 cubic yards of loose rock and gravel; and they dredged and banked against the dam at the head of Marietta Island 24,784 cubic yards of gravel.

Snagging.—The snag-boat *E. A. Woodruff* worked from June 22 to November 20. During this period she lifted 816 snags, 9 cubic yards of rock, 130 tons of bridge iron, and one steam-boat boiler. She broke up and destroyed three steam-boat wrecks, and thirty-two wrecked coal-boats and barges, and completed the removal of six coal-barges, partly removed in former years.

The officer in charge submits tables of the stages of the river during the fiscal year, of the use of high draws in Ohio River bridges, of the losses up to date by collision with Ohio River bridges, and a special report on an automatic water-gauge that is illuminated at night.

July 1, 1889, amount available		$186,482.26
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding and of amount covered by contracts July 1, 1889	$49,834.20	
July 1, 1890, outstanding liabilities	2,095.34	
July 1, 1890, amount covered by uncompleted contracts made prior to July 1, 1889	68,606.63	
July 1, 1890, amount covered by uncompleted contracts made during the fiscal year ending June 30, 1890	29,010.46	
		149,546.63
July 1, 1890, balance available		36,935.63
Amount appropriated by act of September 19, 1890		300,000.00
Amount available for fiscal year ending June 30, 1891		336,935.63

(See Appendix D D 1.)

2. *Operating and care of Davis Island Dam, Ohio River.*—This dam was built to test the adaptability of the system of movable dams to the peculiar conditions of the Ohio River, and to the special character of the commerce that navigates it. It was intended, if successful, to be the first step in the radical improvement of the Ohio River, designed to give a minimum depth of 6 feet at all times, except when ice is running. Incidentally this dam has been of great value to the city of Pittsburgh, by securing an ample depth of water in its harbor throughout the low-water season.

The fiscal year was remarkable for the long continuance of navigable water, and in consequence of this condition the dam was only up for fifty-two days.

Owing to the breaking of some of the axles of the lower lock-gate it became necessary to lower the dam in October to make the needed repairs. Before they were completed a rise came and high water continued so that the dam remained down to the end of the fiscal year. Repairs were resumed in June, but were again interrupted by rises so that they were not finished until after the close of the year.

Two new water-gauges were established to give timely notice of rises.

(See Appendix D D 2.)

3. *Monongahela River, West Virginia and Pennsylvania.*—Lock and Dam No. 8 is practically completed, although some minor details yet need attention. It was opened to navigation on the 8th of November.

The seven lower locks and dams on the Monongahela River belong to the Monongahela Navigation Company, and they create slackwater from Pittsburgh to Dunkard's Creek, a distance of 88 miles. Locks and Dams Nos. 8 and 9, belonging to the United States, continue this slackwater to Morgantown, W. Va., a further distance of 14 miles, the distance from Pittsburgh to Morgantown being 102 miles.

July 1, 1889, amount available		$31,896.27
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding and of amount covered by contracts July 1, 1889	$15,979.07	
July 1, 1890, outstanding liabilities	235.82	
July 1, 1890, amount covered by uncompleted contracts made prior to July 1, 1889	8,168.14	
		24,383.03
July 1, 1890, balance available		7,513.24

(See Appendix D D 3.)

4. *Operating and care of Locks and Dams Nos. 8 and 9, Monongahela River.*—Lock and Dam No. 8 was opened to navigation on the 8th of November. The friction clutches of the operating machinery did not work well, and they were changed to positive clutches. Some of the terre-plein of the lock was washed away by a rise that came over it before the paving was completed.

At Lock 9 some minor repairs were made on the lock-gates and on the apron of the dam. An additional tract of land was also purchased. It is proposed to restore the dam to its original height.

(See Appendix D D 4.)

5. *Purchase of Lock and Dam No. 7, Monongahela River.*—The Monongahela Navigation Company having declined to enter upon negotiations for the sale of this work to the United States under the provisions of the river and harbor act of August 11, 1888, condemnation proceedings were instituted under the further provisions of the same act. The

board of viewers appraised the work at $209,393.52, being $29,393.52 more than it cost to build it, and accordingly the United States took an appeal, which is now pending.

July 1, 1889, amount available		$5,000.00
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$1,466.13	
July 1, 1890, outstanding liabilities	858.40	
		2,324.53
July 1, 1890, balance available		2,675.47
Amount appropriated by act of September 19, 1890		167,000.00
Amount available for fiscal year ending June 30, 1891		169,675.47

(See Appendix D D 5.)

6. *Allegheny River, Pennsylvania.*—The work hitherto done on this river has been limited to the removal of rocks, of which there were a vast number in and near the channel, and to the construction of low dams and dikes of crib-work. The benefit obtained has fully justified the expenditure.

The money thus far appropriated to the improvement of the Allegheny River amounts to $180,000.

During the season the dike at Red Bank was completed, and some small repairs were made on the dams at Nicholson's Island and at Six-Mile Island. The work at Cornplanter's Islands was stopped by an injunction, but the desired result can be obtained by a modification of plan. Two new water-gauges were established on the river.

July 1, 1889, amount available	$9,050.13
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding and of amount covered by contracts July 1, 1889	7,341.95
July 1, 1890, balance available	1,708.18
Amount appropriated by act of September 19, 1890	20,000.00
Amount available for fiscal year ending June 30, 1891	21,708.18

(See Appendix D D 6.)

7. *Dam at Herr's Island, Allegheny River.*—The whole of the fiscal year has been expended in endeavoring to procure the land required for the two ends of this dam, with the result that an agreement has been made for the purchase of the land required on the Pittsburgh side, and that an ordinance has passed one of the councils of Allegheny City to sell the land needed on the right bank for a nominal consideration, provided the dam be made *movable* instead of fixed.

July 1, 1889, amount available		$70,701.78
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$1,747.09	
July 1, 1890, outstanding liabilities	136.50	
		1,883.59
July 1, 1890, balance available		68,818.19
Amount appropriated by act of September 19, 1890		35,000.00
Amount available for fiscal year ending June 30, 1891		103,818.19
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		322,500.00

(See Appendix D D 7.)

8. *Ice-harbor at mouth of Muskingum River, Ohio.*—The work in hand is the construction of a large lock through Dam No. 1, Muskingum River,

in order to permit Ohio River craft to take refuge during ice floods in the pool created by this dam. This lock is also needed to replace Lock No. 1 of the Muskingum River, which has long been in a dangerous condition.

During the past season a large amount of masonry was laid, with the result that the lower and difficult half of the lock is now above low water, and the work of completion can be carried on regardless of ordinary rises in either river. It is probable that the lock will be completed before the close of the calendar year. A new draw must be inserted in the railroad bridge below the lock before the latter can be utilized.

July 1, 1889, amount available		$34,673.15
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding and of amount covered by contracts July 1, 1889	$34,385.37	
July 1, 1890, outstanding liabilities	69.00	
		34,454.37
July 1, 1890, balance available		218.78
Amount appropriated by act of September 19, 1890		30,000.00
Amount available for fiscal year ending June 30, 1891		30,218.78

(See Appendix D D 8.)

9. *Muskingum River, Ohio.*—During the fiscal year the masonry of the new lock at Taylorsville was completed and the upper gates were hung. This lock can not be utilized until a new draw is inserted in the Taylorsville and Duncan's Falls Bridge, which crosses the river just below the new lock. The commissioners of Muskingum County have been ordered to build the draw in question, but no steps have yet been taken to comply with the order. New lower gates were placed in Lock 10.

July 1, 1889, amount available	$40,340.13
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding and of amount covered by contracts July 1, 1889	1,218.80
July 1, 1890, balance available	39,121.33

(See Appendix D D 9.)

10. *Operating and care of the locks and dams on the Muskingum River, Ohio.*—As originally improved by the State of Ohio the Muskingum River contained eleven dams and twelve locks, and furnished continuous navigation for 91 miles from the Ohio River at Marietta to Dresden, at which place a connection was made with the Ohio Canal near its middle point, the canal extending from the Ohio River at Portsmouth to Lake Erie at Cleveland. According to old reports from the State Board of Public Works the locks were built 180 feet long and 36 feet wide, except the lock between Zanesville and Dresden, which was 120 feet long and 22 feet wide. The lifts of the locks are reported to have varied from 8 feet 10 inches to 12 feet 1 inch, and the whole cost of construction was about $1,500,000.

The lock and dam above Zanesville is now destroyed, but 75 miles of slackwater between Zanesville and the Ohio River has been maintained in good navigable condition; on this piece of river there are ten dams, eleven locks, and five lateral canals, with a total length of 3⅔ miles.

During the fiscal year a vigorous effort was made to rebuild the more dangerous locks on the river, being those at Lowell (No. 3), Stockport (No. 6), McConnelsville (No. 7), and Eagleport (No. 8). The former is nearly completed, and considerable progress has been made on the others. The work at Stockport was delayed by a break in the dam. The season was not propitious for work, and, after the work of repair

was begun, it was invariably found necessary to do more than was originally designed.

During the year 150 feet of Dam No. 2, 300 feet of Dam No. 4, and 125 feet of Dam No. 5 were rebuilt as slope-dams, and small repairs were made on Dams 1, 3, and 10.

The left-hand abutment at No. 4 was repaired, and a new dry-stone abutment was built at the lower end of the side dam. A new stone abutment was built at No. 5 and connected with the main shore by an embankment, part of which was afterwards cut away by a flood without serious damage. The left-hand crib abutment at No. 7 was repaired, as was also the right-hand abutment at No. 10. The canals at Lowell, Beverly, and McConnelsville were dredged out. The water-power at the McConnelsville ship-yard was completed and three pairs of lock-gates were built.

Land and lock-keepers' houses were purchased at Luke Chute (No. 5) and at Eagleport (No. 8), as the State of Ohio owned no land at either place. Navigation was stopped throughout the year, except on short sections.

Since the transfer of this work to the United States in 1887 the sum of $532,504.61 has been expended in its reconstruction, care, operation, and maintenance.

(See Appendix D D 10.)

IMPROVEMENT OF THE FALLS OF THE OHIO AND OPERATING AND CARE OF THE LOUISVILLE AND PORTLAND CANAL—IMPROVEMENT OF WABASH RIVER, INDIANA AND ILLINOIS, AND OF WHITE RIVER, INDIANA.

Officer in charge, Capt. Edw. Maguire, Corps of Engineers, since April 11, 1890; Division Engineer, Col. O. M. Poe, Corps of Engineers. These works were in charge of Maj. Amos Stickney, Corps of Engineers, until April 11, 1890.

1. *Falls of the Ohio, Louisville, Kentucky.*—By the river and harbor act approved August 5, 1886, this work, which originally consisted of the enlargement of the upper part of the Louisville and Portland Canal, was made to include the enlargement of the canal basin just above the new locks.

Enlargement of the upper portion of the Louisville and Portland Canal.—The present project was adopted in 1883. It has for its object the enlargement of the upper end of the Louisville and Portland Canal from a point about 400 feet below the railroad bridge to the upper end of the rock ledge which extends to a point about opposite Fourth street. The improvement practically makes a harbor from Tenth street east, and more than doubles the width of the canal from Tenth to Fifteenth street.

The officer in charge was authorized to purchase a plant and finish the excavation work by hired labor. The greater part of this plant has been purchased, and the work will be resumed when the river reaches a favorable stage. An agreement was made with Mr. J. B. Speed for the transportation of the excavated material after it is loaded in cars.

The amount expended to June 30, 1890, was $367,573.89.

Enlarging basin of canal above New Locks.—This work was commenced under a contract with Gleason and Gosnell, dated January 13, 1887. The work performed by these contractors was very unsatisfactory, and the time for completion, after several extensions, having expired December 1, 1888, the officer in charge was authorized to purchase a plant

and finish the work by hired labor. This plan of operations was pursued. A plant was purchased as described in the Report of the Chief of Engineers, Appendix E E 1889, and the work was carried on by hired labor during the fiscal year, until the forced suspension of work by high water.

The amount expended to June 30, 1890, was $70,791.03.

July 1, 1889, amount available		$241,458.73
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$79,823.65	
July 1, 1890, outstanding liabilities	220.69	
		80,044.34
July 1, 1890, balance available		161,414.39
Amount appropriated by act of September 19, 1890		60,000.00
Amount available for fiscal year ending June 30, 1891		221,414.39
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		650,230.40

(See Appendix E E 1.)

2. *Indiana Chute, Falls of the Ohio River.*—The present project is the removal of obstructions in the chute, between the cross-dam and railroad bridge, so as to produce a straight and unobstructed channel 400 feet wide; raising the guiding-dike, which extends along the north side of the chute, and the execution of the plan designed to make this channel available for coal-boats at an 8-foot stage, as proposed by Maj. Amos Stickney, and approved February 1, 1890. The chute was originally very crooked, and full of dangerous reefs and points. The work already done has resulted in an unobstructed channel 250 feet wide.

The amount expended to June 30, 1890, was $116,104.30.

July 1, 1889, amount available	$23,946.20
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	61.00
July 1, 1890, balance available	23,885.20
Amount appropriated by act of September 19, 1890	25,000.00
Amount available for fiscal year ending June 30, 1891	48,885.20
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	113,610.97

(See Appendix E E 2.)

3. *Operating and care of Louisville and Portland Canal.*—During the fiscal year the canal was open for the passage of commerce with the exception of ninety days, when it was closed on account of high water.

An improvement, consisting in raising the lock-walls and middle gates by timber construction, was completed. The available locking stage was thereby increased from 11.45 to 12.70 feet. Work on the revetment of slopes was completed.

The two dredges with steam-boat tender were employed in the removal of 101,540 cubic yards of mud from the canal and its approaches. The dry-dock was used twenty-one days for repairs to other than Government vessels. One of the bridges over the canal was refloored, and two thoroughly painted. The necessary repairs to buildings, gates, and scows were made.

It is proposed during the coming year to replace the middle gates of *the new locks*, and prepare for the renewal of the guard-gates of

both the old and new locks, if it should become necessary, and to excavate the channel below the locks.

The total receipts from all sources amount to $380.13.

(See Appendix E E 3.)

4. *Wabash River, Indiana and Illinois.*—This river has been separated into two portions with reference to its improvement, Vincennes, Ind., being the dividing point, and appropriations have been made for each division.

Below Vincennes.—The first appropriation for the improvement of this river was made in 1872. The present project is the removal of rock ledges, sand-bars, snags, and other obstructions; the closing of chutes and construction of spur-dikes, all with a view of obtaining a navigable channel of 3½ feet depth from the mouth of the river to Vincennes, and the construction of a lock and dam at Grand Rapids near Mount Carmel.

Work on the lock and dam was carried on during the summer and fall of 1889, and May and June, 1890, to the extent permitted by the amount of stone on hand or under contract, there having been no appropriation last year. The work has now reached a stage at which it is safe from injury.

The work done at Grayville, consisting of bank protection, levee and spur-dikes has proved successful and the constructions are in good condition.

Amount expended to June 30, 1890, $228,048.47.

July 1, 1889, amount available		$29,014.16
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$17,058.82	
July 1, 1890, outstanding liabilities	861.38	
		17,920.20
July 1, 1890, balance available		11,093.96
Amount appropriated by act of September 19, 1890		60,000.00
Amount available for fiscal year ending June 30, 1891		71,093.96
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		161,600.00

(See Appendix E E 4.)

Above Vincennes.—The project for the improvement of this part of the river was the removal of snags and other obstructions and the construction of wing-dams where necessary. The very small unexpended balance on hand, $244.93, prevented any work being done. The river, which was much improved by the removal of snags in 1888, has again become obstructed.

The amount expended on this river above Vincennes to June 30, 1890, was $70,748.22.

July 1, 1889, amount available	$251.78
July 1, 1890, outstanding liabilities	6.85
July 1, 1890, balance available	244.93
Amount appropriated by act of September 19, 1890	5,500.00
Amount available for fiscal year ending June 30, 1891	5,744.93
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	14,500.00

(See Appendix E E 4.)

5. *White River, Indiana.*—The project for the improvement of this river has for its object the obtaining of a depth of 3½ feet at low water, between the mouth and the railroad bridge above Hazelton.

The amount appropriated for this work by the act of August 11, 1888, was $5,000, but its expenditure was made conditional upon certain changes to be made in the railroad bridges over White River. These changes not having been made, and the balance available July 1, 1889, having been only $223.77, no work was done.

The amount expended on White River to June 30, 1890, was $102,294.34.

July 1, 1889, amount available	$5,223.77
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	18.11
July 1, 1890, balance available	5,205.66
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	12,500.00

(See Appendix E E 5.)

IMPROVEMENT OF GREAT KANAWHA, ELK, AND GAULEY RIVERS, WEST VIRGINIA; AND OF NEW RIVER IN VIRGINIA AND WEST VIRGINIA.

Officer in charge, Capt. Thomas Turtle, Corps of Engineers, until July 23, 1889, and after that, Col. W. P. Craighill, Corps of Engineers.

1. *Great Kanawha River, West Virginia.*—This river flows through a fertile and picturesque region, filled with mineral wealth, especially coal and salt. It was by nature divided into a number of pools, some of considerable length and depth, separated by shoals of gravel and coarse sand, which were the principal obstructions to navigation in low water, there being often on them at such seasons but a few inches of water. In some of the pools were found shallow places, also obstructing navigation. There were also snags and loose rocks in the channel. The navigation above Charleston was more obstructed than below. Above it was almost suspended in summer.

The coal and salt were generally sent out on rises, which enabled the boats to pass safely over the obstructions that otherwise would stop their movements entirely. The use of the river for the movement of these valuable products was therefore unsatisfactory and intermittent. By the agency and superintendence of a board acting under the State, first of Virginia and then of West Virginia, considerable improvement in the river was from time to time effected, tolls being charged on the commerce for the payment of expenses.

The object of the improvement begun several years ago by the United States was to give a constant navigable depth of at least 6 feet throughout the whole length of the Kanawha to its mouth at the Ohio River, to be accomplished by large locks and dams.

Those already built have been about 300 by 50 feet.

The peculiarity of most of the dams is that they can be lowered when the stage of the water in the river will suffice over the shoals. This gives them the name of "movable dams," and enables an open river to be had where the water is high enough.

Dams 3 and 2, both above Paint Creek, are fixed, as the declivity of the river in that section is too great to permit the advantageous use of the movable system.

Up to June 30, 1889, the amount expended was $1,976,203.33.

At that date Locks and Dams 2, 3, 4, 5, and 6 had been completed.

The amount expended in the year ending June 30, 1890, exclusive of outstanding liabilities, was $70,572.09.

Lock No. 7 was let at contract November 26, 1888, as soon as possible after the passage of the river and harbor act, and Lock No. 8 August 20, 1889, much delay having arisen in getting possession of the latter site, the season of 1888 for work in the river being thus practically lost for both. The season of 1889 was a bad one on account of the unusual number and duration of freshets. Negotiations are in progress for procuring site No. 9.

Had funds been available, all the locks and dams needed for this improvement could have been begun at the same time and finished in three years with much economy to the United States, and with manifest advantage in the use of the improved water-way. The development of commerce on this river has been very great since the improvement by the United States, although the project has as yet been only partially executed for want of money.

Summarily the work for the fiscal year has been the following:

Building coffer-dams, dredging, quarrying and cutting stone on construction of Locks Nos. 7 and 8; pumping and excavating within coffer-dam and placing concrete at No. 7; building lock-keeper's house, office and out-buildings at No. 8; surveys and borings to rock for definite location and procurement of site at No. 9; making test levels between sites 6 and 8; making irons for gate anchorage, line fastenings, etc., for Locks 7 and 8; extending riprapping and banking dam at No. 2; dredging at Harvey's Shoal; removing obstructions with crane-boat and dredge; operating five (Nos. 2, 3, 4, 5, and 6), completed locks and dams; repairing and extending riprapping mainly at Nos. 3 and 6; placing 15 improved hurters at No. 4; commencing construction of new lower lock gates at No. 3.

During the seasons of low water the value of the improvement is shown in a very marked manner, as free and sufficient navigation is then easily maintained over the improved part of the river while navigation may be entirely suspended below the lowest dam and above the upper pool.

July 1, 1889, amount available		$320,942.34
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$70,572.09	
July 1, 1890, outstanding liabilities	3,000.00	
July 1, 1890, amount covered by uncompleted contracts made during the fiscal year ending June 30, 1890	208,361.40	
		281,933.49
July 1, 1890, balance available		39,008.85
Amount appropriated by act of September 19, 1890		300,000.00
Amount available for fiscal year ending June 30, 1891		339,008.85
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		670,000.00

(See Appendix FF 1.)

2. *Operating and care of the locks and dams on the Great Kanawha River, West Virginia.*—Amount expended during the fiscal year ending June 30, 1890, $22,057.30.

(See Appendix F F 2.)

3. *Elk River, West Virginia.*—The Elk is one of the chief tributaries of the Great Kanawha. Its course is tortuous, but the country through which it flows is rich in minerals and well fitted for agriculture and grazing.

The average low-water width is about 200 feet, with narrows at the rapids of about 150 feet in width and occasional portions of about 300 feet in width. The pools vary in depth from 3 to 10 feet, and are separated by rapids over shoals of cobble-stones and gravel, on which there has been, at low seasons, a depth of but a few inches of water. The average fall per mile in the river from Braxton Court House down is about 2½ feet, but is not uniformly distributed, being greatest (about 4 feet per mile) in the central section and less (about 2 feet) in the upper and lower sections. Freshets of small height are of frequent occurrence but rapidly pass off. The annual rise in the spring is about 10 or 12 feet. An extraordinary rise is sometimes had of 25 to 30 feet, but the duration is not great.

The approved project of improvement has been the removal of rocks, snags, overhanging trees, etc., and the cutting of narrow sluices through the rapids and shoals. The principal interests to be served are those of lumbering and rafting, but much country produce is also carried down-stream in small boats, which return with merchandise, etc.

The first appropriation was in June, 1878. The total amount expended to June 30, 1890, has been $20,925.11, with great advantage. Nothing was done in the year ending June 30, 1890.

July 1, 1889, amount available	$574 89
July 1, 1890, balance available	574.89
Amount appropriated by act of September 19, 1890	2,500.00
Amount available for fiscal year ending June 30, 1891	3,074.89

(See Appendix F F 3.)

4. *Gauley River, West Virginia.*—Operations for the improvement of the Gauley River were instituted by an examination made in 1887 in accordance with the provisions of the river and harbor act of August 5, 1886. It was then pointed out that a valuable improvement of the 12 miles of river from the mouth to the "Roughs" could be made at an expense of $10,000, and that a great advantage would follow the expenditure of $65,000 in the 26-mile reach, called the "Roughs," in facilitating and cheapening the bringing to market of millions of feet of lumber of the most valuable and varied kinds.

The river and harbor act of August 11, 1888, appropriated $3,000. The project approved for the expenditure of this small sum contemplated the removal of ledges of solid rock and the making of channels through eighteen shoals of loose rock and bowlders, commencing at Scramble Creek, about three-fourths of a mile above the mouth and extending to the pool above Rich Creek, a distance of 10 miles. The work was carried on by the hire of labor and the purchase of materials in open market, the circumstances not permitting contract work from considerations of economy and advantage.

The project calls for a bateau channel 30 feet wide and 2 feet deep, but in order that the improvement might begin to be effective as far up as possible, a width of but 20 feet has been thus far given. No work was done in the year ending June 30, 1890, on account of continued high water. The expenditure up to June 30, 1890, has been $1,315.42.

July 1, 1889, amount available	$1,733.58
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	49.00
July 1, 1890, balance available	1,684.58
Amount appropriated by act of September 19, 1890	3,000.00
Amount available for fiscal year ending June 30, 1891	4,684.58
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	4,000.00

(See Appendix F F 4.)

5. *New River, from the mouth of Wilson, in Grayson County, Virginia, to the mouth of Greenbrier River, West Virginia.*—The appropriations have been made in such manner as to divide this portion of the river into three sections as follows:

	Miles.
Upper, or Lead Mines	62
Middle, or New River Bridge	43
Lower, or Greenbrier	86½

Throughout this distance the navigable channel consisted of natural chutes through the ledges and shoals of varying widths, rarely over 1 foot in depth, in some places so tortuous as to render navigation extremely difficult and dangerous.

The original project adopted for the improvement of these natural channels was to widen them to 30 or 50 feet, as might be required, deepen them to 2 feet, and straighten such as needed it. This was for bateau navigation; the improvement, however, to be made in such a manner as to aid the work should a greater depth and width be required in the future.

A small steam-boat, draught 12 inches when light, having been built at Hinton in the fall of 1878, rendered it necessary to make the channel in that section 50 feet wide at all points, and in many from 75 feet to 100 feet, the depth of 2 feet being retained. This steam-boat was not adapted in dimensions and power to the navigation of the river and was withdrawn.

The original plan of improvement has been adhered to, except that the width of channel on the middle and upper divisions has been reduced to 20 feet, and on the former to 10 feet for several miles, to allow iron to be shipped from the furnaces above.

There was no appropriation for this river in 1883, 1884, or 1885. July 1, 1886, there was a balance remaining unexpended of $3,000 from the appropriation of August 2, 1882. This pertained by special designation of the law to the portion of the river above Foster's Falls, which are not passable. The balance remained unexpended because of the impassability of these falls. As the disconnection with routes of transportation caused by these falls would practically disappear on the completion of the railroad up Cripple Creek, and as boats could then ship to the railroad their freight at Porter's Ferry above the lead mines and the falls, it was concluded to improve the condition of Williamson's ledges and shoals. This work was continued as late as the season allowed, a small balance of funds being left unexpended, but not large enough to justify the resumption of operations in the summer of 1886.

There was an appropriation of $10,000 in the law of August 5, 1886, applicable only to the portion of the river above the lead mines. When the money became available it was too late to commence operations in 1886. For more than one reason it seemed inexpedient to expend this

appropriation in the year ending June 30, 1888. The portion of the river to which it is applicable is above Foster's Falls, and these can only be passed by one or two locks. There was also strong reason for doubt whether, considering the present development of that section of the country, the construction of such locks would be justifiable, even if the money were available. The construction of railroads near this stream had diminished very much the importance of the improvement of the portion above Foster's Falls. After a careful re-examination of the subject and a reconnaissance of the river and its vicinity, it was decided to postpone the expenditure of the appropriation until the will of Congress could be further ascertained.

In the river and harbor act of August 11, 1888, it was, however, directed that the balance should be spent in improving the river between Ivanhoe Furnace, in Wythe County, and the mouth of Wilson Creek. Operations in accordance with this direction were therefore commenced June 9, 1889, and continued until October 10, 1889.

In 1885 there was a channel 2 feet deep and 20 feet wide from Ivanhoe Furnace to within 600 feet of the head of Wilkinson's Shoals and Ledges, a distance of 3.9 miles.

In 1889 this channel, with the same width and depth, was extended to the lower end of the approach to the Gulf, a distance of 5 miles from the initial point, with four-tenths of a mile farther up the river, partially improved.

The amount expended in the year ending June 30, 1890, has been $6,394.45, and the total to that date, $109,733.21.

July 1, 1889, amount available	$8,736.24
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	6,394.45
July 1, 1890, balance available	2,341.79
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	159,000.00

(See Appendix F F 5.)

IMPROVEMENT OF TRADEWATER, KENTUCKY, AND LICKING RIVERS—OPERATING AND KEEPING IN REPAIR LOCKS AND DAMS ON THE GREEN AND BARREN AND KENTUCKY RIVERS, KENTUCKY—IMPROVEMENT OF BIG SANDY RIVER, WEST VIRGINIA AND KENTUCKY, AND OF GUYANDOTTE, LITTLE KANAWHA, AND BUCKHANNON RIVERS, WEST VIRGINIA.

Officer in charge, Maj. D. W. Lockwood, Corps of Engineers, with Lieut. W. L. Sibert, Corps of Engineers, under his immediate orders; Division Engineer, Col. O. M. Poe, Corps of Engineers.

1. *Tradewater River, Kentucky.*—This river was practically closed before the work of improvement commenced, by a rock bar near its mouth, and higher up by logs, snags, drift-piles, leaning trees, and bars.

The present project, adopted in 1881, provides for clearing the river and its banks of obstructions, and opening up a channel 40 feet wide and 2½ feet deep during six months of the year. The improvement to extend 41 miles up-stream from its mouth in the Ohio.

Up to June 30, 1889, $10,195.56 had been expended, resulting in securing a channel through the rock bar near the mouth of the river, removing the obstructions in the channel for a distance of 24½ miles, clearing the banks for a distance of 14 miles, and deadening the timber on the banks for the remaining 27 miles.

During the fiscal year ending June 30, 1890, $3,448.25 were expended, resulting in the completion of the work to a point 41 miles from the Ohio.

No further appropriation recommended for the present.

July 1, 1889, amount available	$6,304.44
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	3,448.25
July 1, 1890, balance available	2,856.19

(See Appendix G G 1.)

2. *Operating and keeping in repair the locks and dams on the Green and Barren Rivers, Kentucky.*—When the United States acquired possession of these improvements, December 11, 1888, navigation of the system was broken at Lock No. 3, Green River, the river wall of that lock having fallen into the river, the lower end of the land wall of No. 1, Barren, was badly cracked and liable to fall at any time, and both walls of No. 2, Green River, were in a dangerous condition. The channel of the river was much obstructed by snags and slides.

During the fiscal year ending June 30, 1889, $46,557.77 were expended in obtaining proper plant and material, in removing the fallen wall at No. 3, Green, and excavating in rear of land wall of No. 1, Barren, preparatory to taking down the broken part of the wall.

The amount expended during the fiscal year ending June 30, 1890, was $154,580.57, and resulted in completing the removal of the fallen wall at No. 3, Green, the construction of a coffer-dam inclosing the site for the new wall, and the purchase and cutting of stone for its reconstruction. At Lock No. 1, Barren River, a coffer-dam was built across the lower end of the lock pit, the broken wall taken down, and the stone for its renewal purchased and cut. A part of the dam was also repaired.

A snag-boat was built by contract, but could do little in the way of removing obstructions until near the end of the year, owing to high water.

The estimate of the cost of operating and care, etc., for the fiscal year ending June 30, 1891, is $158,939.28.

(See Appendix G G 2.)

3. *Kentucky River, Kentucky.*—The condition of the river when the United States assumed charge of its improvements was as follows: The five locks and dams with their approaches, built by the State of Kentucky, were in a dilapidated condition, and the channel was much obstructed by snags and leaning trees.

The project for the improvement, adopted in 1879, called for the necessary repairs to the five locks and dams and the extension of slack-water navigation for a draught of 6 feet, by the construction of additional locks and dams to Beattyville, a distance of 261 miles from the mouth of the river.

Up to the close of the fiscal year ending June 30, 1889, $1,120,586.76 had been expended, resulting in restoring the locks and dams to a navigable condition, clearing the channel and banks of obstructions, and the commencement of two new locks. No results in the way of increased availabilities for the purposes of navigation and commerce can be expected until these locks are completed.

During the fiscal year ending June 30, 1890, $42,490.58 were expended, and resulted in the completion of the delivery of stone for Lock No. 6, the quarrying of 1,555 cubic yards of stone for the Beattyville lock, and the dressing of 540 cubic yards of stone for same. A part of the

old Bear Trap and dam at Beattyville was torn out and a coffer-dam inclosing the lock-site built.

July 1, 1889, amount available		*$47,418.24
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$42,141.25	
July 1, 1890, outstanding liabilities	349.33	
		42,490.58
July 1, 1890, balance available		4,927.66
Amount appropriated by act of September 19, 1890		180,000.00
Amount available for fiscal year ending June 30, 1891		184,927.66
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		1,674,000.00

(See Appendix G G 3.)

4. *Operating and keeping in repair the locks and dams on Kentucky River, Kentucky.*—The first allotment for this work was for the fiscal year ending June 30, 1885, at which time only four locks could be operated; these required extensive repairs at the time, and the dams and approaches were in a more or less dilapidated condition.

The amount expended to June 30, 1889, was $240,855, and resulted in reopening Lock No. 5 and placing the other locks and dams to a serviceable condition, the building of guide-walls and approaches, the construction of one double and five single lock-keepers' dwellings, and in grading, paving, and draining grounds about the locks.

The amount expended during the fiscal year ending June 30, 1890, was $53,695.76. This amount was expended in the construction of a new dredge-boat of the Osgood pattern; two dump-scows, and in general repairs to the locks and dams, etc., besides keeping the river clear of snags.

The amount estimated for operating and care of the locks and dams on this river for the fiscal year ending June 30, 1891, is $48,653.75.

(See Appendix G G 4.)

5. *Licking River, Kentucky, from Farmer's to West Liberty.*—This stream was originally much obstructed by logs, snags, rocks, and leaning trees, as well as by fish-dams constructed by private parties.

The project for the improvement was adopted in 1888, and provides for removing the rocks, snags, and bowlders from the river-bed.

The amount expended to June 30, 1889, was $792.51, and resulted in procuring a suitable outfit for the work, and in removing the most pronounced obstructions for a distance of 22 miles above Farmer's, after which the working party proceeded to West Liberty to work downstream.

During the fiscal year ending June 30, 1890, $2,075.41 were expended, which resulted in removing a large number of snags, rocks, etc., which had formed the most serious obstructions to navigation and rafting.

July 1, 1889, amount available	$2,207.49
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	2,075.41
July 1, 1890, balance available	132.08
Amount appropriated by act of September 19, 1890	3,000.00
Amount available for fiscal year ending June 30, 1891	3,132.08

* The change in amount available from that reported July 1, 1889, has been necessary owing to records showing amount "In Treasury" as five dollars less than it *actually was on* above date.

Amount (estimated) required for completion of existing project ..... Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	$11,680.00

(See Appendix G G 5.)

6. *Big Sandy River, West Virginia and Kentucky.*—When the United States commenced improving this stream it and its forks were much obstructed by rocks, bars, logs, snags, and leaning trees. During the low-water season navigation was practically suspended.

The present approved project was adopted in 1878, and provided for improving the push-boat and rafting facilities of the river and forks by removing obstructions, etc. This was modified in 1880, to secure slack-water navigation by the construction of a test lock and dam near Louisa, Ky.

Up to the close of the fiscal year ending June 30, 1889, $242,298.98 had been expended, resulting in the completion of the masonry of the lock and abutment, the partial completion of the lock-gates and wickets, and the removal by blasting of 2,000 cubic yards of rock from the lower approach to the lock and placing it behind the abutment. The upper approach was also completed.

The forks had been cleared of obstructions for a distance of 86 miles on the Levisa Fork and 100 miles on the Tug Fork, and the main river to the Ohio had also been cleared out.

During the fiscal year ending June 30, 1890, $8,028.38 were expended, which resulted in the completion of the lock-gates, wickets, and movable dam in the head bay, together with the machinery for operating the lock-gates and wickets and the driving of 100 piles for the dam. As there was no money available for the improvement of the forks nothing was done.

July 1, 1889, amount available		$23,201.02
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$7,998.38	
July 1, 1890, outstanding liabilities	30.00	
		8,028.38
July 1, 1890, balance available		15,172.64
Amount appropriated by act of September 19, 1890		31,000.00
Amount available for fiscal year ending June 30, 1891		46,172.64
Amount (estimated) required for completion of existing project ..... Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		145.31

(See Appendix G G 6.)

7. *Guyandotte River, West Virginia.*—This stream was originally much obstructed by snags, logs, leaning trees, the remains of old dams, and mill-dams owned by private parties which required removal.

The project for the improvement was adopted in 1878, and provided for the removal of existing obstructions, natural and artificial, so as to form a channel 30 feet wide, with a least depth of 18 inches, during five months of the year, and extending up the river a distance of 122 miles from the Ohio.

Up to the close of the fiscal year ending June 30, 1889, $12,500 had been expended, which resulted in the partial improvement of the river for a distance of 119 miles; but many of the worst obstructions, consisting of mill-dams, etc., still remain, as they were owned by private parties.

During the fiscal year ending June 30, 1890, $1,873.45 were ex-

pended and resulted in clearing out a large number of snags, bowlders, and trees, besides deepening the water through Rogers' dam and on many of the shoals. Five mill-dams will have to be removed, at a cost of $10,000 to complete the improvement.

July 1, 1889, amount available		$2,000.00
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889		1,873.45
July 1, 1890, balance available		126.55
Amount appropriated by act of September 19, 1890		2,000.00
Amount available for fiscal year ending June 30, 1891		2,126.55

(See Appendix G G 7.)

8. *Little Kanawha River, West Virginia.*—This river, at the time improvements were commenced by the United States, was much obstructed by logs, snags, leaning trees, etc., above that portion controlled by the Little Kanawha Navigation Company.

The original project adopted in 1876 was for the removal of Beaver and Nailor Bend rocks, and for cleaning out snags and fallen trees. This was modified in 1880 by the adoption of an additional project for the construction of a lock and dam 2 miles above Burning Springs, W. Va.

Up to June 30, 1889, $161,199.09 had been expended.

At that date the river above that portion covered by the slackwater system was in fair condition for rafting logs, but no benefits to navigation had resulted from the amount expended on the lock and dam, nor can any be expected until they are completed.

During the fiscal year ending June 30, 1890, $8,676.87 were expended, and resulted in the completion of the lock-walls and a lock-keeper's dwelling.

July 1, 1889, amount available		$9,675.91
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$8,646.87	
July 1, 1890, outstanding liabilities	30.00	
		8,676.87
July 1, 1890, balance available		999.04
Amount appropriated by act of September 19, 1890		40,000.00
Amount available for fiscal year ending June 30, 1891		40,999.04

(See Appendix G G 8.)

9. *Buckhannon River, West Virginia.*—This stream was originally so obstructed by rocks and log jams that timber could be floated out only on a 12 feet rise.

The project for its improvement, adopted in 1884, provides for the formation of a rafting channel 24½ miles long, with a minimum width of 30 feet.

Up to the close of the fiscal year ending June 30, 1889, $3,959.92 had been expended, resulting in clearing the channel for about 14½ miles, so that logs could be floated over this portion on a 5 feet rise.

During the fiscal year ending June 30, 1890, $495.68 were expended, which resulted in removing 1,106 cubic yards of rock and three log jams.

The river is not used now for rafting purposes, as a railroad has been built along it to the timber country.

July 1, 1889, amount available	$540.08
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	495.68
July 1, 1890, balance available	44.40
Amount appropriated by act of September 19, 1890	1,000.00
Amount available for fiscal year ending June 30, 1891	1,044.40

(See Appendix G G 9.)

LAKE HARBORS AND RIVERS.

IMPROVEMENT OF HARBORS ON LAKE SUPERIOR.

Officer in charge, Maj. James B. Quinn, Corps of Engineers, with Lieut. G. W. Goethals, Corps of Engineers, under his immediate orders, from September 2 to 18, 1889, and Lieut. G. D. Fitch, Corps of Engineers, under his immediate orders since November 6, 1889; Division Engineer, Col. O. M. Poe, Corps of Engineers.

1. *Harbor at Grand Marais, Minnesota.*—This small natural basin was not of sufficient depth or adequately sheltered for the purposes of general commerce, and, as it was essential to have a harbor of refuge at this locality, it was proposed to provide the requisite shelter by building a pier out from Mayhew's Point, and to secure the necessary depth of water by dredging.

A little dredging was done in 1879, and work on the pier commenced in 1880.

The available anchorage area having full 16 feet depth is at present 15.1 acres, an increase of more than 3 acres during the year just closed. The quantity of material dredged during the year was 47,927.6 cubic yards. The pier is 350 feet long and in fairly good condition.

The total expenditure to June 30, 1890, was $93,675.49.

The amount expended during the fiscal year was $711.12.

July 1, 1889, amount available	$2,035.63
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	711.12
July 1, 1890, balance available	1,324.51
Amount appropriated by act of September 19, 1890	50,000.00
Amount available for fiscal year ending June 30, 1891	51,324.51

(See Appendix H H 1.)

2. *Harbor at Agate Bay, Minnesota.*—This is a shipping port for iron ore, and when the breakwater piers are built will form a harbor of refuge. It is 27 miles east of Duluth.

The project for the improvement of this harbor was adopted in 1887, and contemplates the erection of two piers projecting from the headlands of the bay and inclosing about 109 acres of water area. The eastern pier is to be 1,000 feet long and the western one 900 feet. Work upon the east pier was commenced in 1887, and to the 400 feet built that year there was added 150 feet last year, making a total of 550 feet of pier completed to date at a cost of $35,519.79.

The amount expended during the year ending June 30, 1890, was $1,299.70.

The beneficial effects of the work done are greater than were antici-

pated, the tranquillity of the harbor has been greatly augmented, vessels are no longer obliged to put to sea during storms, but can safety under the shelter of the breakwater.

July 1, 1889, amount available	$3,2
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,2
July 1, 1890, balance available	1,9
Amount appropriated by act of September 19, 1890	25,0
Amount available for fiscal year ending June 30, 1891	26,9
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	181,7

(See Appendix H H 2.)

3. *Harbor at Duluth, Minnesota.*—The original project for the impr ment of the harbor, adopted in 1871, consisted of a breakwater in L Superior, outside of Minnesota Point, in continuation of one already c menced by the Northern Pacific Railroad Company. This breakw was destroyed by a storm in 1872 and abandoned. In 187 Cong provided for maintaining the canal through Minnesota Point, which been constructed by the city of Duluth, and for dredging channel Superior Bay to the Duluth docks.

Work under this project was continued until 1881, at which time piers of the canal had been repaired and somewhat extended, a har basin dredged of moderate capacity, and a narrow channel dred in Superior Bay from Duluth to deep water at Connor's Point. amount expended under this project was $270,051.81.

The present project was adopted in 1881 and modified in 1884 1888, the object being to preserve the piers bordering the canal, dre ing an inner harbor to accommodate vessels drawing 16 feet of wa channel parallel with the Park Point dock line 100 feet wide, char east of Rice's Point 200 feet wide and 17 feet deep, and channel north shore of St. Louis Bay 200 feet wide, 17 feet deep.

The amount expended under present project to June 30, 1890, $267,881.89, and has resulted in increasing the dredged area of har basin to about 104 acres, exclusive of private dredging, removing sh from area previously dredged, giving the whole dredged basin a m mum depth of 16 feet, deepening the Blast Furnace Channel to a depth, maintaining the canal piers and commencement of channels of Rice's Point and on North shore of St. Louis Bay.

Work during the year just closed consisted in dredging channel of Rice's Point, about 50 feet wide and 16 feet deep, making pres length of channel about 5,040 feet, and dredging channel on north sh of St. Louis Bay from 40 to 45 feet wide and 14 feet deep, making present length of channel about 12,900 feet. The amount of mate excavated from former channel was 107,981.3 cubic yards, and from latter 118,083.8 cubic yards.

The canal piers are in a decrepit condition, and the entire work ne to be replaced with an improved and permanent structure.

The harbor basin and connecting channels will eventually req deepening to 22 feet. The channels recently commenced should be c pleted at an early date, both for the accommodation of commerce

as a matter of economy. The ruling depths in the portions of the harbor dredged by the United States are—

	Feet.
In canal	17
In the inner basin or harbor	16
In Blast Furnace Channel to a point opposite Elevator E	16
From point opposite Elevator E through dredged channel along eastside of Rice's Point to the St. Louis River	12
In channel on north shore of St. Louis Bay for a distance of about 12,900 feet	14
In new channel east of Rice's Point for a distance of about 5,040 feet	16

July 1, 1889, amount available		$17,330.42
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$3,314.50	
July 1, 1890, outstanding liabilities	250.42	
		3,564.92
July 1, 1890, balance available		13,765.50
Amount appropriated by act of September 19, 1890		100,000.00
Amount available for fiscal year ending June 30, 1891		113,765.50
Amount (estimated) required for completion of existing project Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		224,526.00

(See Appendix H H 3.)

4. *Harbor at Superior Bay and Saint Louis Bay, Wisconsin*—Originally the natural entry to Superior Bay was obstructed with shifting bars having at most but 9 feet depth of water over them. The citizens of Superior attempted to remedy this by constructing piers to confine the outflowing waters of the bay, and this work was taken up by the United States in 1867, and has successfully maintained since then a ruling depth of 16 feet between the piers.

The piers are 350 feet apart, and a good deal of dredging has been necessary to obtain the required depth between them, and the channels leading to Connor's Point and the Quebec Dock, and a new connecting channel in St. Louis Bay. The original project of 1867 has, therefore, been modified from time to time to meet the needs of the rapidly increasing capacity of the vessels visiting this port, the last modification being made by act of Congress approved August 5, 1886, which added improvement of channel in St. Louis Bay.

In carrying out the original project, with modifications, there has been expended to date the sum of $495,046.59.

The expenditure of $37,670.15 last year, including amount covered by contracts and liabilities July 1, 1889 ($34,914.18), was made in dredging 85,157¼ cubic yards of material from the main channel in Superior Bay, 3 5,428¾ cubic yards from the Quebec Dock Channel, and 84,285⅝ cubic yards from the St. Louis Bay Channel.

The entry piers need extensive repairs, particularly the superstructure. The beach protection is intact though insufficient. The entry and dredged channels have full 16 feet depth.

July 1, 1889, amount available		$18,593.18
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$2,542.64	
July 1, 1890, outstanding liabilities	213.33	
		2,755.97
July 1, 1890, balance available		15,837.21
Amount appropriated by act of September 19, 1890		65,000.00
Amount available for fiscal year ending June 30, 1891		80,837.21

Amount (estimated) required for completion of existing project..... Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	$226,736.00

(See Appendix H H 4.)

5. *Harbor at Ashland, Wisconsin.*—Ashland Harbor is located at the head of Chequamagon Bay, and originally had no protection from the waves which rolled into the bay or from the waves generated within the bay itself by storms.

A project for the construction of a breakwater 8,000 feet long northeast of the town, and for dredging a channel in front of the wharves of the city to accommodate vessels drawing 16 feet of water was approved, but was modified in 1889 so as to provide for a pile and slab pier 4,650 feet long. This breakwater was completed as far as contemplated in 1889. It is now being repaired, and the slab filling brought up to the level in those places where it had settled. These repairs will be completed early in July from funds remaining on hand.

The amount expended during the year was $10,075.42.

The total amount expended under approved project to date was $66,398.73.

The breakwater, though of insufficient length to give full protection to all the wharves of the city, has nevertheless had a marked influence in improving the tranquility of the harbor.

July 1, 1889, amount available		$26,176.69
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$3,963.25	
July 1, 1890, outstanding liabilities	6,112.17	
		10,075.42
July 1, 1890, balance available		16,101.27
Amount appropriated by act of September 19, 1890		60,000.00
Amount available for fiscal year ending June 30, 1891		76,101.27
Amount (estimated) required for completion of existing project..... Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		30,000.00

(See Appendix H H 5.)

6. *Harbor at Ontonagon, Michigan.*—The entrance to Ontonagon River, which forms the harbor, had but 7 feet depth in 1867, at which time the project for securing 12 feet depth by building parallel piers on either side of the mouth, extending to the 18-foot curve of depth in Lake Superior, and dredging a channel between the piers, was adopted.

The west pier has reached a length of 2,675 feet, and is very nearly out to the 18-foot curve of depth, as proposed. But this curve has advanced in the meantime, owing to the very considerable volume of sand carried into the lake by the river, and since it appears probable that the advance of the bar will keep pace with the extension of the piers, unless a very considerable extension is made at once, a consideration scarcely to be expected, it does not appear that economic considerations would justify any further extension of the piers at present. The east pier is 2,315 feet in length.

For a time it seems that better results will be secured, after the piers are put in repair and the superstructures to outer cribs of west pier are finished, by dredging across the bar after each spring freshet.

During the fiscal year the west pier has had three 50-foot substructure cribs added to it, the superstructures to the three cribs of west pier and one crib of east pier, sunk in 1887, completed, and some general repairs made to the superstructure of the remainder of the piers. The

channel between the piers has a depth of 12 feet; on the bar the depth is not so great.

The amount expended during the fiscal year just closed was $614.15.

The total cost of the improvement to date is $296,157.89.

July 1, 1889, amount available	$2,556.26
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	614.15
July 1, 1890, balance available	1,942.11
Amount appropriated by act of September 19, 1890	10,000.00
Amount available for fiscal year ending June 30, 1891	11,942.11
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	55,670.00

(See Appendix H H 6.)

7. *Eagle Harbor, Michigan.*—Previous to the improvement of Eagle Harbor the entrance was obstructed by a rocky reef, with 8½ feet of water over the shoalest part.

The project for the improvement of this harbor was adopted in 1866, and modified in 1868, 1874, and 1878. The plan as finally carried out consisted in blasting and dredging through the rocky ledge a channel 130 feet wide and 14 feet deep, and marking it by two guiding-cribs, one on each side of the channel, and the removal of a number of bowlders.

The amount expended to the close of the fiscal year ending June 30, 1890, was $94,513.67, and has resulted in carrying out the above project, the work having been completed in 1879 and meeting the present demands of commerce.

No appropriation is asked for this harbor, as the funds available will probably be sufficient to keep the work in good order for several years longer.

July 1, 1889, amount available	$2,486.33
July 1, 1890, balance available	2,486.33

(See Appendix H H 7.)

8. *Harbor at Marquette, Michigan.*—Originally this harbor afforded no protection to vessels from the easterly or northeasterly storms, and in 1866 a project was approved for the construction of a breakwater composed of cribs filled with rock, and projecting from the shore into the bay a distance of 2,000 feet. This pier was finished practically as projected in 1875.

Since its commencement extensive repairs have been made to the superstructure, and last fall a severe storm seriously damaged this part. It was repaired at a cost of $5,062.74.

As the timber composing the superstructure has been in place far longer than supposed probable, it is essential that it be replaced by more durable material. A project for a concrete superstructure was approved in February, 1890. Its estimated cost is $149,454.36.

In the river and harbor bill of August 11, 1888, provision was made for the extension of the breakwater. The estimated cost of the 1,000 feet of proposed extension is $121,000. Last summer work upon the first 180 feet of this extension was commenced, but owing to the violence of storms towards the end of the season, before the work was finished, a greater portion of the crib substructure was ruined. There was finished but 60 feet of crib-work *and 180 feet* of riprap foundation.

The amount expended during the fiscal year ending June 30, 1
was $6,138.22.

The total cost of the work to date is $347,579.62.

July 1, 1889, amount available		$12,7
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$5,988.22	
July 1, 1890, outstanding liabilities	150.00	
		6,1
July 1, 1890, balance available		6,6
Amount appropriated by act of September 19, 1890		40,0
Amount available for fiscal year ending June 30, 1891		46,6
Amount (estimated) required for completion of existing and proposed project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		230,4

(See Appendix H H 8.)

9. *Harbor of Refuge at Grand Marais, Michigan.*—Originally the trance to this harbor was obstructed by a bar, having but about 6 depth of water upon it.

The project for its improvement, adopted in 1881, has for its obje deep and safe channel into the harbor, making it a harbor of ref This object is to be attained by building parallel piers, projecting the lake, and dredging out a channel between them, connecting the d water of the lake with that of the harbor.

The proposed length of each pier was 1,800 feet. The west pier now reached a length of 1,456.58 feet, and the east pier 853 feet.

A channel 150 feet wide and 17 feet deep was dredged out between piers, but as the sand was the height of the superstructure, it was expected to remain open. No accession of sand has taken place though the deep channel has shoaled until it has but from 7 to 9 depth. This is better than was anticipated, and indicates that fur dredging may be proceeded with safely.

The amount expended during the present fiscal year was $3,15 and during this period 75,392.7 cubic yards of material have been moved from the channel, 656 feet of superstructure has been adde the west pier, and 553 feet to the east pier.

The total amount expended under approved project to June 30, 1 was $179,571.78.

July 1, 1889, amount available		$4,8
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$3,102.05	
July 1, 1890, outstanding liabilities	48.70	
		3,1
July 1, 1890, balance available		1,6
Amount appropriated by act of September 19, 1890		22,3
Amount available for fiscal year ending June 30, 1891		24,0
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		246,4

(See Appendix H H 9.)

10. *Establishment and maintenance of harbor lines in Portage L Michigan.*—Pursuant to the authority granted by Congress, by ac August 5, 1886, harbor lines were established at Portage Lake, Mi *gan.*

Some of the stamp-mills continued to deposit their refuse in the lake after the harbor lines were established.

Preparatory to commencing proceedings against the mill-owners, the United States District Attorney for the western district of Michigan asked to be supplied with certain assistance and information, and accordingly a re-examination of Portage Lake was made in November, 1889, and the results supplied to the United States District Attorney in December, 1889.

(See Appendix H H 12.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENT, TO COMPLY WITH REQUIREMENTS OF RIVER AND HARBOR ACT OF AUGUST 11, 1888.

It appearing from the preliminary examination made by the local engineer that the following localities are worthy of improvement, and the public necessity therefor being apparent from the facts and reasons reported, which are concurred in by the Chief of Engineers, Major Quinn was charged with and completed their survey, the results of which were transmitted to Congress and printed in Ex. Doc's. of the Fifty-first Congress, first session.

1. *Minnesota Point, at Superior, at the west end of Lake Superior, Wisconsin, to ascertain what, if anything, should be done to preserve the same from the inroads of the lake and for the protection of the harbor.*—Printed as House Ex. Doc. 51. (See also Appendix H H 10.)

2. *Duluth, Minnesota.*—Printed as House Ex. Doc. 217. (See also Appendix H H 11.)

IMPROVEMENT OF HARBORS OF THE WEST SHORE OF LAKE MICHIGAN NORTH OF WAUKEGAN, ILLINOIS—IMPROVEMENT OF FOX AND WISCONSIN RIVERS.

Officer in charge, Maj. C. E. L. B. Davis, Corps of Engineers, with Lieut. G. D. Fitch, Corps of Engineers, under his immediate orders until November 5, 1889, and with Lieut. H. E. Waterman, Corps of Engineers, under his immediate orders since October 10, 1889; Division Engineer, Col. O. M. Poe, Corps of Engineers.

1. *Manistique Harbor, Michigan.*—The natural channel of entrance to the mouth of the Manistique River was 7 feet deep. By private enterprise 3,000 feet of slab-piers had been built at the mouth of the river and a channel dredged to 10 feet before any appropriation had been made by the Government.

The project for the improvement of the harbor was adopted in 1880, and consisted in dredging between the piers built by the Chicago Lumbering Company, increasing the depth of the channel to 12 feet for a width of 150 feet.

By the acts of 1880 and 1881 the sum of $6,000 was appropriated for this harbor in order to dredge a channel between the private piers of the above-mentioned dimensions. Dredging was done to the amount of 11,780 cubic yards at a cost of $2,989.21, and work was then suspended in consequence of the refusal of the company controlling the harbor to rectify their pier-lines when rebuilding the same.

During the fiscal year ending June 30, 1890, $256.03 was expended in surveying the harbor.

No work has been done since work was suspended in 1881.

July 1, 1889, amount available	$3,1
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	2
July 1, 1890, balance available	2,8

(See Appendix I I 1.)

2. *Cedar River Harbor, Michigan.*—Previous to improvement mouth of Cedar River was 175 feet wide and 8 to 10 feet deep wi 3-foot bar in front.

Improvements had been made by private parties prior to the mencement of Government work.

The project of improvement was adopted in 1883, with a modifica in the direction of the piers in 1884, the object being to afford a trance channel of navigable width and 14 feet in depth.

Up to June 30, 1889, there had been expended $27,664.98, resul in the construction of two pile-piers 754 and 301 feet long respecti in continuation of the slab-docks built by private enterprise, a channel that in October, 1885, was 50 feet wide and 13 feet deep 100 feet wide for a depth of 11 feet.

During the fiscal year ending June 30, 1890, $46.95 have been pended in sounding and contingent expenses, but no work of impr ment has been carried on since the close of the season of 1885.

Soundings taken in May of the present year show a channel of 12, and 13 feet, with corresponding widths of 60, 40, and 20 feet, do less due to dredging by private parties.

July 1, 1889, amount available	$2,3
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	
July 1, 1890, balance available	2,2
Amount (estimated) required for completion of existing project (Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.)	108,0

(See Appendix I I 2.)

3. *Menomonee Harbor, Michigan and Wisconsin.*—Previous to the provement of this harbor the depth of water at the mouth of the nomonee River was about 4 feet, and the river was navigable for b of that draught for some 2 miles above its mouth.

The project for the improvement of the harbor was adopted in and modified in 1874, the object being to afford a channel of entran navigable width and not less than 14 feet depth.

The amount expended up to June 30, 1889, was $200,933.26, re ing in the construction of two piers, 400 feet apart, the north pier 1 feet long and the south pier 2,710 feet, with a dredged channel bet 14 feet deep and 270 feet wide, this channel extending across a bar a 350 feet beyond the south pier.

During the fiscal year ending June 30, 1890, $5,990.61 has bee pended in repairs to the north pier and to the dredging plant, in cases by purchase of material and hired labor.

July 1, 1889, amount available	$11,0
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	5,9
July 1, 1890, balance available	5,0
Amount appropriated by act of September 19, 1890	54,0
Amount available for fiscal year ending June 30, 1891	59,0

(See Appendix I I 3.)

4. *Oconto Harbor, Wisconsin.*—In its natural condition the channel at the entrance to the Oconto River was obstructed by a bar with less than 2 feet of water over it. Previous to 1881, when the first appropriation was made for its improvement, the citizens, by the construction of a small amount of slab-pier and by dredging, had increased the depth to 3½ feet.

The project of improvement, adopted in 1882, proposes to secure an 8-foot channel from Green Bay to the city of Oconto, a distance of 2 miles, by dredging and constructing piers, at an estimated cost of $150,000.

The total amount expended up to June 30, 1889, was $51,992.17, resulting in the building of two piers, the north pier 1,603 feet and the south pier 2,151 feet in length, the latter being the full length contemplated by the approved project, and in the removal of 207,641 cubic yards of material. Owing to the narrowness of the dredged channel and the soft character of the material the spring freshets have a tendency to obliterate the dredging of the previous year.

During the fiscal year ending June 30, 1890, $12,253.45 have been expended in dredging and in repairs to the dredging plant. At the close of the year there was a depth of 10 feet at the entrance and a channel of 8 feet up to Spies' Slough, a distance of about 7,700 feet, with widths varying from 50 to 100 feet.

July 1, 1889, amount available	$15,986.33
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	12,253.45
July 1, 1890, balance available	3,732.88
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	82,000.00

(See Appendix I I 4.)

5. *Pensaukee Harbor, Wisconsin.*—The original depth of water at the mouth of the Pensaukee River was 2 feet, increased by private enterprise to from 7 to 9 feet for a width of 30 feet.

The project of improvement for this harbor was adopted in 1883, and consisted of the construction of a single slab-pier 2,500 feet long, in continuation of the pier built by private enterprise, and dredging a channel 10 feet deep and 100 feet wide on the south side of the pier.

The total amount expended up to June 30, 1889, was $10,939.08, resulting in the construction of 1,300 feet of the proposed extension of the pier and the dredging of 5,698 cubic yards of material, making a channel 25 feet wide and 10 feet deep. No work has been done on this harbor since the season of 1885.

During the fiscal year ending June 30, 1890, $258.66 has been expended in making a survey and examination of the Government pier.

There being at present no commercial or navigation interests to be benefited by improving the harbor, and the harbor itself not being needed as a harbor of refuge, further operations have been suspended.

July 1, 1889, amount available	$4,059.92
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	258.66
July 1, 1890, balance available	3,801.26
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	35,000.00

(See Appendix *I I 5.)*

6. *Green Bay Harbor, Wisconsin.*—Before the improvement of t harbor was begun the channel between the mouth of the Fox Ri and the deep water in Green Bay was circuitous and narrow, with l 6 feet of water at its shoalest point.

The project of improvement was adopted in 1866, and subsequen modified, so as to provide increased depth, in 1872 and 1874, the obj being to provide a dredged channel 200 feet wide, 14 feet deep, an miles long, in place of the natural channel, with a revetted cut acr Grassy Island.

There was expended up to the close of the fiscal year ending Ju 30, 1889, $277,523.47, resulting in a dredged channel 10,600 feet lo 200 feet wide, and 14 feet deep, except where occasional shoals reduc the depth to 13 feet, and in the construction of 1,325 linear feet of p and timber revetment of the sides of the cut through Grassy Island.

During the fiscal year ending June 30, 1890, $2,801.76 has been pended in restoring, as far as available funds would permit, the cha nel, which had shoaled, to its intended width and depth. This wo was going on at the close of the fiscal year.

July 1, 1889, amount available	$10,057
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	2,801
July 1, 1890, balance available	7,255
Amount appropriated by act of September 19, 1890	10,000
Amount available for fiscal year ending June 30, 1891	17,255
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	10,000

(See Appendix I I 6.)

7. *Harbor of Refuge at entrance of Sturgeon Bay Canal, Wisconsin.* Before the construction of this harbor was undertaken the Lake Mic gan entrance to the Sturgeon Bay and Lake Michigan Ship Canal w entirely unprotected from storms ranging from northeast to southwe

The project of constructing a harbor of refuge at this point w adopted in 1873, and modified in 1879 and 1880. The modified proje as carried out, consists of two piers, each 1,344 feet long, 850 feet apa at the shore-line, protecting the lake entrance of the canal, and co verging so as to make the harbor entrance 335 feet wide, inclosing area of about 10 acres with a depth of at least 16 feet.

The total expenditure at this harbor up to June 30, 1889, w $161,428.58, resulting in the entire completion of the piers as project and in the dredging of 132,344 cubic yards of material, giving a chan nearly 16 feet deep at the entrance and 14 feet or more thence to t canal, making a depth of 14 feet over the greater part of the shelter area.

During the fiscal year ending June 30, 1890, $3,474.76 has been pended in repairs of shore ends of both piers and in dredging, 7,4 cubic yards of material having been removed.

July 1, 1889, amount available	$3,566
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	3,474
July 1, 1890, balance available	91
Amount appropriated by act of September 19, 1890	3,000
Amount available for fiscal year ending June 30, 1891	3,091

(See Appendix I I 7.)

8. *Ahnapee Harbor, Wisconsin.*—Previous to the improvement of this harbor the depth of water at the mouth of the Ahnapee River was only about two feet.

The project of improvement, adopted in 1875, and modified in 1884, provided for the formation of a small artificial harbor, connected with the lake by a channel 100 feet wide and 12 feet deep, formed by the construction of two piers extending to the 18-foot contour, with a 200-foot entrance between the pier-heads.

The total amount expended up to June 30, 1889, was $154,189.94, resulting in the construction of two piers, the north one 1,102 feet long, and the south one 1,125 feet, and in the removal of 25,731 cubic yards of rock, and 102,308 cubic yards of sand.

During the fiscal year ending June 30, 1890, $4,582.26 has been expended in extending the north pier 50 feet, in excavating 4,147 cubic yards of rock and 5,330 cubic yards of sand, all the work being done by hired labor and open purchase of material. The channel between the piers was dredged to 12 feet with a width of 60 feet and about one-third of the area of rock excavation has 12 feet of water over it, with 9 feet over the remaining two-thirds.

July 1, 1889, amount available	$5,266.73
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	4,103.43
July 1, 1890, balance available	1,163.30
Amount appropriated by act of September 19, 1890	6,000.00
Amount available for fiscal year ending June 30, 1891	7,163.30
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	9,000.00

(See Appendix I I 8.)

9. *Kewaunee Harbor, Wisconsin.*—The natural entrance to this harbor was through the Kewaunee River. The river mouth was not more than 20 feet wide, with a depth of about 2 feet at its shoalest point, and was obstructed by submerged bowlders.

The project of improvement was adopted in 1881. Its design was to cut a channel 14 feet deep through a neck of land between the river and the lake at a point about 2,000 feet south of the river mouth, and to continue this channel to deep water in the lake by the construction of two parallel piers 200 feet apart, extending from each side of the cut lakeward to the 18-foot contour.

The total amount expended on this harbor up to the close of the fiscal year ending June 30, 1889, was $46,297.59, in addition to which the local harbor commissioners had expended $8,042.72. At that time 1,000 feet of the north pier and 775 feet of the south pier had been constructed and a channel 60 feet wide and 12 feet deep had been dredged, 133,291 cubic yards of material having been removed by the Government dredges.

During the fiscal year ending June 30, 1890, $8,479.78 have been expended, resulting in the extension of the south pier 300 feet.

July 1, 1889, amount available	$668.01
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	479.78
July 1, 1890, balance available	188.23
Amount appropriated by act of September 19, 1890	20,000.00
Amount available for fiscal year *ending June 30, 1891*	20,188.23

Amount (estimated) required for completion of existing project ..... Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	$117,000.00

(See Appendix I I 9.)

10. *Two Rivers Harbor, Wisconsin.*—Previous to the improvement of this harbor the natural channel was obstructed by a bar covered by but 2 or 3 feet of water.

The project of improvement adopted in 1870 provided for the formation of a channel of navigable width and not less than 12 feet deep, to be accomplished by the construction of two piers extending from the mouth of Two Rivers lakeward to the 18-foot contour in Lake Michigan and dredging a channel between them.

The amount expended up to the close of the fiscal year ending June 30, 1889, was $199,260.63, resulting in the construction of two parallel piers, as follows: A north pier 1,810 feet long, the inner 1,060 feet of which consists of pile-pier, and the outer 750 feet of crib-pier; a south pier 1,710 feet long, 960 feet of which is pile-pier, and the outer 750 feet crib-pier; the crib sections of the two piers begin at points opposite each other and are 230 feet apart; the pile sections are 270 feet apart; 253,372 cubic yards of material have been removed by dredging.

During the fiscal year ending June 30, 1890, there has been expended $687.96 in refilling and riprapping the north and south piers in places.

July 1, 1889, amount available	$1,239.37
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	687.96
July 1, 1890, balance available	551.41
Amount appropriated by act of September 19, 1890	3,000.00
Amount available for fiscal year ending June 30, 1891	3,551.41
Amount (estimated) required for completion of existing project ..... Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	62,000.00

(See Appendix I I 10.)

11. *Manitowoc Harbor, Wisconsin.*—Previous to the improvement of this harbor but 3 feet of water existed at the shoalest point over the bar at the mouth of the Manitowoc River.

The original project adopted in 1852 provided for the construction of two parallel piers, 220 feet apart, extending from the mouth of the river to the 12-foot contour in Lake Michigan. In 1881 this was modified so as to secure a deeper channel by extending the piers to a depth of 18½ feet and dredging to not less than 14 feet.

The total amount expended up to June 30, 1889, was $298,893.89, resulting in the construction of two piers, the north one 1,970 and the south one 1,900 feet long, 228 feet apart at the shore-line and 250 feet at the outer ends, and in the removal of 184,997 cubic yards of material by dredging.

During the fiscal year ending June 30, 1890, but $213.50 have been expended in surveying the harbor, care and superintendence, no work of improvement having been done during the year.

July 1, 1889, amount available	$973.11
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	213.50
July 1, 1890, balance available	759.61
Amount appropriated by act of September 19, 1890	8,000.00
Amount available for fiscal year ending June 30, 1891	8,759.61

Amount (estimated) required for completion of existing project ..... Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	$362.54

(See Appendix I I 11.)

12. *Sheboygan Harbor, Wisconsin.*—Previous to the improvement of this harbor the natural channel had a depth not exceeding 4 feet on the bar at the entrance of the river.

The original project for the improvement of this harbor was adopted in 1852 and had for its object the formation of a 12-foot channel entrance to the mouth of the Sheboygan River. This was modified in 1873 so as to secure a deeper channel by further pier extension and dredging. Both projects were completed within their estimated cost and a channel was formed 100 feet wide with a depth of 15 to 16 feet between the piers. This was further modified in 1881, the present project having for its object to deepen the channel still further by extending the piers to the 20 foot contour in the lake and dredging to a depth of 18 feet between their outer ends, the depth decreasing to 14 feet at the shore-line.

The total expenditures up to June 30, 1889, amounted to $289,770.86, resulting in the construction of a north and a south pier, 2,044 and 2,260 feet long, respectively, and the removal by dredging of 207,193 cubic yards of material. There was then a navigable channel 14 feet deep.

During the fiscal year ending June 30, 1890, $12,386.96 have been expended, $10,254.54 of which was by contract work for the extension of the south pier 200 feet and $2,132.42 by hired labor and purchase of material in open market for repairing 150 feet of the south pier above the water surface.

July 1, 1889, amount available	$2,617.85
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,386.96
July 1, 1890, balance available	1,230.89
Amount appropriated by act of September 19, 1890	15,000.00
Amount available for fiscal year ending June 30, 1891	16,230.89
Amount (estimated) required for completion of existing project ..... Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	67,000.00

(See Appendix I I 12.)

13. *Port Washington Harbor, Wisconsin.*—The natural channel at the mouth of the Sauk River was narrow, and at the shoalest point had a depth of but 1 foot.

The original project for the improvement of this harbor was adopted in 1869 and provided for two parallel piers extending to 10 feet of water in Lake Michigan and the excavation of an interior basin. This plan was modified in 1870 and again in 1876, and now provides for the excavation of two interior basins with a combined area of 5¾ acres, with a depth of 12 feet, and a channel of the same depth connecting the basins with the lake.

The total expenditure up to June 30, 1889, was $169,161.54, and resulted in the construction of a north and south pier respectively 920 and 1,226 feet long, with 400 feet of revetment along the north bank of the river, extending to the inner end of the south pier; in the formation of two interior dredged basins of 2¾ and 3 acres, respectively, with an

average depth of about 9 feet in the north and 8 feet in the west basin, and in making a navigable channel between the piers of 11 feet.

During the fiscal year ending June 30, 1890, $3,307.41 have been expended in dredging and in minor repairs to the north pier, with a resulting improvement in the width and depth of channel and depths of basins.

July 1, 1889, amount available	$5,346.36
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	3,307.41
July 1, 1890, balance available	2,038.95
Amount appropriated by act of September 19, 1890	3,000.00
Amount available for fiscal year ending June 30, 1891	5,038.95
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	4,000.00

(See Appendix I 1 13.)

14. *Harbor of Refuge at Milwaukee Bay, Wisconsin.*—The project for the work was approved in 1881, and contemplated the formation of an artificial harbor by inclosing a portion of Lake Michigan forming Milwaukee Bay within an outer breakwater of crib-work upon a stone foundation. This harbor will furnish 417 acres of safe mooring-ground beyond the 18-foot contour, and about twice this area beyond the 12-foot contour.

The actual length of the breakwater when completed will be 7,250 feet.

Work began in 1881, and up to June 30, 1889, there had been expended $360,812.22, resulting in the completion of 3,550 feet of substructure and 3,100 feet of superstructure, leaving 3,700 feet of the former and 4,150 feet of the latter to complete the work.

During the fiscal year ending June 30, 1890, $34,089.50 was expended, resulting in an extension of 200 feet of substructure and 225 feet of superstructure, leaving 3,500 feet of substructure and 3,925 feet of superstructure to complete the breakwater.

The harbor is now used to a considerable extent as a shelter from northeast storms and its value will rapidly increase as the breakwater is extended.

July 1, 1889, amount available	$6,233.24
July 1, 1889, amount reported as covered by existing contracts, too large by	7,273.05
	13,506.29
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	4,207.44
July 1, 1890, balance available	9,298.85
Amount appropriated by act of September 19, 1890	80,000.00
Amount available for fiscal year ending June 30, 1891	89,298.85
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	338,000.00

(See Appendix I I 14.)

15. *Milwaukee Harbor, Wisconsin.*—The original depth of water at the mouth of the Milwaukee River was not more than 3½ feet.

The original project was adopted in 1852, and was directed to secur-

ing 12 feet of water at the entrance to the river and to protecting the channel by parallel piers. In 1868 this was modified so as to secure a channel 18 feet deep, by extending the piers 600 feet and dredging. The project has been completed, and consequently the only expenditures now demanded are for the maintenance of the piers by timely repairs and of the depth of the channel by dredging.

Up to the close of the fiscal year ending June 30, 1889, there had been expended on this harbor $294,103.87, in addition to $321,355.66 expended by the city of Milwaukee, resulting in the completion of the modified project of 1868.

During the fiscal year ending June 30, 1890, $10,840.08 has been expended, $6,100 of which was under a special act of Congress of March 17, 1890, for removing sand-bars formed at the entrance of the harbor.

This money was expended in repairs to 400 feet of the superstructure of the south pier, and under the special act in obtaining a channel 19 feet deep.

July 1, 1889, amount available	$1,326.34
Amount appropriated by act of March 17, 1890, for removing obstructions, Harbor at Milwaukee, Wis	6,100.00
	7,426.34
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	6,684.21
July 1, 1890, balance available	742.13
Amount appropriated by act of September 19, 1890	6,000.00
Amount available for fiscal year ending June 30, 1891	6,742.13
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	14,000.00

(See Appendix I I 15.)

16. *Racine Harbor, Wisconsin.*—The entrance to this harbor originally varied in depth from absolute closure after storms to about 6 feet.

The original project was adopted in 1842 or 1843 and contemplated a channel 12 feet deep. In 1866 the project was modified to providing a channel 15 feet deep.

There has been expended on this harbor up to June 30, 1889, $238,706.55, resulting in the construction of a north and south pier 1,460 and 1,070 feet long respectively, and a dredged channel 16 feet deep.

During the fiscal year ending June 30, 1890, $3,056.36 has been expended in restoring the channel, which had shoaled to 13½ feet, to a width of 50 feet and a depth of 16 feet, 9,627 cubic yards of material having been removed by dredging.

The constant shoaling at the entrance to this harbor shows that the piers will have to be extended several hundred feet in order to maintain the intended depth. Some 500 feet of the superstructure of the piers should be rebuilt.

July 1, 1889, amount available	$3,599.95
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	3,056.36
July 1, 1890, balance available	543.59
Amount appropriated by act of September 19, 1890	17,500.00
Amount available for fiscal year ending June 30, 1891	18,043.59

Amount (estimated) required for completion of existing project Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	$64,500.00

(See Appendix I I 16.)

17. *Kenosha Harbor, Wisconsin.*—The original depth of water at the mouth of Pike Creek varied from absolute closure to 3 feet.

The original plan of improvement was adopted in 1852 and was directed to securing a channel 12 feet deep by constructing parallel piers and dredging between them. This plan was modified in 1866 so as to secure 15 feet of water by extending the piers and dredging deeper.

There was expended upon this harbor up to June 30, 1889, $226,596.71, resulting in the construction of two piers, north and south, 1,600 and 800 feet in length respectively, 150 feet apart, with a channel of varying depth. In 1875 and 1876 the channel was dredged to 15 feet, but the subsequent appropriations have not been sufficient to maintain this depth, so that the periodical dredging has only provided an available channel of about 12 feet.

During the fiscal year ending June 30, 1890, $1,421.63 have been expended in dredging a channel 150 feet wide and 15 feet deep across the bar which had formed across the harbor entrance with but 9.8 feet on its shoalest part.

July 1, 1889, amount available	$2,856.86
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,421.63
July 1, 1890, balance available	1,435.23
Amount appropriated by act of September 19, 1890	17,500.00
Amount available for fiscal year ending June 30, 1891	18,935.23
Amount (estimated) required for completion of existing project Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	64.500.00

(See Appendix I I 17.)

18. *Waukegan Harbor, Illinois.*—Previous to improvement there was no navigable channel or natural harbor at this place, the adopted project contemplating the construction of an artificial harbor.

A project was adopted in 1852 which provided for the construction of a breakwater parallel to the shore in 20 feet of water. One crib was placed in position but was carried away by a storm, and the work was then abandoned. In 1872 another project was submitted for a breakwater in 24 feet of water. No action was taken on this.

The present project was adopted in 1880, and provides for the construction of an exterior basin of sufficient capacity for local trade by inclosing a portion of Lake Michigan with pile-piers, the entrance-channel between the piers and the inclosed area to be dredged to 12 feet.

There has been expended on this harbor up to the close of the fiscal year ending June 30, 1889 $100,765.37, resulting in the construction of 2,285 feet of pile-pier and the removal of 17,805 cubic yards of material.

During the fiscal year ending June 30, 1890, $10,151.01 has been expended in dredging by contract 63,069 cubic yards of material and in the purchase of about 60 cords of stone for riprapping the outer end of the south pier. At the present time there is more than 10 feet of water over the dredged area, though a bar has formed inside of the piers with but 7.2 feet of water over it.

The prolongation of the fore-shore will necessitate an extension of the piers,

July 1, 1889, amount available	$7,157.76
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	3,074.05
July 1, 1890, balance available	4,083.62
Amount appropriated by act of September 19, 1890	35,000.00
Amount available for fiscal year ending June 30, 1891	39,083.62
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	86,000.00

(See Appendix I I 18.)

19. *Fox and Wisconsin Rivers, Wisconsin.*—The works for the improvement of the Fox and Wisconsin rivers were purchased by the United States from the Green Bay and Mississippi Canal Company in 1872. With the exception of one stone lock they were all temporary structures and were in bad condition. There was no low-water navigation on the Upper Fox, and on the Lower Fox navigation was uncertain.

The adopted project for the improvement of the Fox River contemplated the replacing of the temporary structures with permanent works, the construction of five additional stone locks on the upper river, and widening and deepening the channels throughout the river and canals to 6 feet depth and 100 feet width.

The method adopted for the Wisconsin River was to contract the channel-way by stone and brush wing-dams in order to give increased depth by concentration and scour.

The estimate for both rivers, made in 1874 and 1876, was $3,745,663.

The general project of the improvement of the Fox and Wisconsin rivers was referred to the Board of Engineers, who, after systematic observations of the effect of the dams on the improved section of the Wisconsin River, submitted a report, contained in House Ex. Doc. No. 65, Forty-ninth Congress, second session, recommending that no further work be done on wing-dams in the Wisconsin River with a view to improving its navigation.

The original project, therefore, as far as it relates to the Wisconsin River, has been abandoned, and the work confined to the Fox River under the modified project of a Board of Engineers submitted September 17, 1884, published in the Annual Report of the Chief of Engineers for 1885, approved by the Secretary of War December 10, 1885, as further modified by authority of the Chief of Engineers May 14, 1886.

The modified project applies only to the Fox River and its needs, and provides for the renovation of eleven old locks and the deepening and widening of the channel of the Fox River from Montello to Green Bay to 6 feet depth and 100 feet width, and that from Portage to Montello 4 feet of water at low water be maintained, the estimate for which was $602,000.

The amount expended on the Fox and Wisconsin Rivers from 1867 up to the close of the fiscal year ending June 30, 1889, including outstanding liabilities and $145,000 paid to the Green Bay and Mississippi Canal Company for works of improvement under act of June 10, 1872, was $2,754,873.13.

The result of this expenditure was:

On the Fox River.—The construction of 14 new locks of stone; 13 dams, 4 of which are temporary; 12 cut-offs; 10 miles of canals dredged and deepened. Over 2,000,000 cubic yards of material were dredged

from the Upper Fox, and all temporary structures repaired and maintained in working order. Navigation had thus been rendered continuous throughout the season of 1889 from Portage to Green Bay, there being at ordinary stage of water 2½ feet on the Upper Fox and 5¼ feet on the Lower Fox, except at the entrance of Lake Winnebago, where there was only 4½ feet.

Under the modified project there remained to be done 2,800,000 cubic yards of dredging and rock excavation, mainly on the Upper Fox, and a dam at Appleton with sluice-ways.

On the Wisconsin River.—One hundred and eight thousand five hundred and twelve linear feet of wing-dams had been constructed over a distance of 50 miles, of which a section 9.2 miles in length below Portage had been completed. The result was an increased depth of navigation wherever the works had been applied. On account of the shifting nature of the sand-bars there was never any regular navigation on the river.

During the fiscal year ending June 30, 1890, $42,704.59 has been expended, and the following work done:

A levee 2.8 miles in length was built at Portage, Wisconsin, to prevent the overflow of the Wisconsin River into the Upper Fox River.

This levee is 6 feet wide on top with side slopes of one on one and a half, the top being 2 feet above the high-water level of 1881.

The lower dam at Appleton, Wis., 425 feet long with five 20-foot sluices, was completed.

Repairs to dredging plant were made and dredging done at Menasha Canal and the south outlet of Lake Winnebago.

July 1, 1889, amount available		$58,259.35
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$42,703.34	
July 1, 1890, outstanding liabilities	174.46	
		42,877.80
July 1, 1890, balance available		15,381.55
Amount appropriated by act of September 19, 1890		100,000.00
Amount available for fiscal year ending June 30, 1891		115,381.55
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		346,000.00

(See Appendix I I 19.)

20. *Operating and care of locks and dams on the Fox River, Wisconsin.*—Under the continuous appropriation for operating and care of canals and other works of navigation, it is proposed to maintain existing navigation by timely repairs to old locks until they are replaced by new, and to continue repairs of works that have already been completed and used, injured by floods or otherwise.

The amount expended under the indefinite appropriation provided by section 4 of the river and harbor act of July 5, 1884, up to the end of the fiscal year ending June 30, 1889, was $231,905.44.

During the fiscal year ending June 30, 1890, $76,874.27 has been expended, the detailed statement appended to the report of the local engineer officer showing the items of expenditure.

(See Appendix I I 20.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENT, TO COMPLY WITH REQUIREMENTS OF RIVER AND HARBOR ACT OF AUGUST 11, 1888.

It appearing from the preliminary examination made by the local engineer that the following localities are worthy of improvement, and the public necessity therefor being apparent from the facts and reasons reported, which are concurred in by the Chief of Engineers, Major Davis was charged with and completed their survey the results of which were transmitted to Congress and printed in Ex. Doc's. of the Fifty-first Congress, first sesssion.

1. *Harbor at mouth of Fond du Lac River, in Lake Winnebago, Wisconsin.*—Printed as House Ex. Doc. 24. (See also Appendix I I 21.)

2. *Menomonee Harbor, from the waters of Green Bay to N. Ludington and Company's mill, Wisconsin, for a channel 16 feet deep and 200 feet wide.*—Printed as House Ex. Doc. 34. (See also Appendix I I 22.)

IMPROVEMENT OF THE HARBORS OF CHICAGO AND CALUMET, ILLINOIS—IMPROVEMENT OF ILLINOIS AND CALUMET RIVERS—LOCATION OF THE ILLINOIS AND MISSISSIPPI CANAL—OPERATING AND CARE OF LA GRANGE LOCK ON THE ILLINOIS RIVER.

Officer in charge, Capt. W. L. Marshall, Corps of Engineers; Division Engineer, Col. O. M. Poe, Corps of Engineers.

1. *Chicago Harbor, Illinois.*—The present project was adopted in 1870 and modified in 1878.

The project consists in:

(1) The formation of an outer harbor or basin, by inclosing a portion of Lake Michigan just south of and adjoining the entrance to Chicago River, for the purpose of increasing the harbor facilities of the port of Chicago.

(2) The construction of an exterior breakwater in deep water north of the entrance to Chicago River and about 1 mile distant, to shelter the approach to the river and outer harbor entrances, and to form a harbor of refuge at the southern end of Lake Michigan. There has been expended upon this project since 1870, $1,594,887.90, which expenditure has resulted:

In the completion of the outer harbor, except 267,000 cubic yards of dredging, to attain 16 feet in depth throughout the required basin.

In the completion of the exterior breakwater, 5,413 feet in length; and in keeping dredged to a depth of 16 feet the entrance to Chicago River.

During the fiscal year the work consisted in:

(a) *Exterior breakwater.*—In the completion and placing by contract eleven cribs, or 748 linear feet of substructure, and the completion of superstructure over 1,156 linear feet of substructure, 408 feet of which was over cribs sunk during the previous fiscal year, completing the work.

(b) *Outer basin.*—The gap produced in the southerly breakwater by the storm of December 4, 1885, was repaired by placing five cribs, each 100 feet in length, and completing the superstructure over them. Four of these cribs were partially built during the previous fiscal year.

(c) During the season of 1889 a light-ship was maintained off the southeastern extremity of the exterior breakwater to mark that structure. Since its completion it has been turned over to the Light-house establishment for lighting.

The whole of the superstructure over the easterly breakwater of the

outer basin, and over the outer section of the north pier at the entrance to the Chicago River is now in a very rotten and unsafe condition, and requires renewal.

The outer basin has never fulfilled the purposes of its construction on account of the litigation that has existed for many years as to the riparian ownership along the lake front, and the dredging in that area may well be postponed until the lake front is in demand for harbor and dock purposes, when the material will be valuable for filling docks.

July 1, 1889, amount available		$65,192.12
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$47,474.95	
Amount reserved for expenses Office Chief of Engineers	152.00	
		47,626.95
July 1, 1890, balance available		17,565.17
Amount appropriated by act of September 19, 1890		100,000.00
Amount available for fiscal year ending June 30, 1891		117,565.17
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		72,000.00

(See Appendix J J 1.)

2. *Calumet Harbor, Illinois.*—This improvement is to furnish a safe and practicable entrance to Calumet River and the port of South Chicago by parallel piers 300 feet apart, extending from shore to deep water in the lake and by dredging between them to 16 feet in depth at low water.

The work commenced in 1870, and at the close of the fiscal year 1890 there had been expended $408,205.76, as the result of which 3,640 linear feet of the North Pier and 2,020 linear feet of the South Pier have been completed and 384,346 cubic yards of material dredged, giving a channel 16 feet in depth instead of 7 feet, as originally existed.

During the past fiscal year (1890) no work of improvement has been done. The office building of the harbor improvement was repaired and painted and the work cared for and watched.

The channel has deteriorated until the 16-foot channel is too narrow to be practicable and dredging is required to restore it to a sufficient width and depth.

The superstructure on portions of the North and South pier for 1,694 feet is rotten and absolutely worthless. A further extent of superstructure of about 770 feet of these piers is in bad condition. The 1,694 feet should be immediately renewed.

The south pier should be extended 800 linear feet to prevent sands drifting into the channel, and there is a demand to accommodate heavily laden boats that the channel be dredged to 18 feet in depth.

July 1, 1889, amount available		$5,006.79
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	812.55	
Amount reserved for expenses Office Chief of Engineers	12.00	
		824.55
July 1, 1890, balance available		4,182.24
Amount appropriated by act of September 19, 1890		20,000.00
Amount available for fiscal year ending June 30, 1891		24,182.24
Amount (estimated) required for maintenance. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		47,000.00

(See Appendix J J 2.)

3. *Illinois River, Illinois.*—The present project contemplates the extension of the work heretofore done by the State of Illinois from the mouth of Copperas Creek to the Mississippi River, a distance of about 135 miles, which project includes the building of two locks 350 feet long between mitre-sills, 75 feet width of lock chamber, with 7 feet of water over the mitre-sills at low water level of 1879, and dredging the channel where necessary to obtain 7 feet depth at low water in the pools thus created.

The sites selected for the two locks are, one at Kampsville, 31 miles above the mouth of the Illinois; the other at La Grange, 79 miles above the mouth of the river.

The ultimate object of the improvement is the construction of a ship-canal from the southern end of Lake Michigan to the Mississippi River, of sufficient capacity to accommodate large-sized Mississippi steamboats, and for military and naval purposes.

The State of Illinois, aided by the United States, has executed part of the project by the construction of two locks of the dimensions above stated; one at Henry and one at Copperas Creek, respectively, completing, except dredging, that part of the improvement between La Salle, Ill., and the mouth of Copperas Creek.

The La Grange lock and dam are practically completed, and the lock open for navigation. The foundation of the Kampsville lock is completed, and nearly all of the stone required for its construction has been purchased under contract, and is now piled at the site, ready for laying it in the wall. A small amount of work is yet to be done on the La Grange dam, and grading and cleaning up around the lock. The Kampsville lock and dam are also to be completed, and dredging done amounting to more than 2,000,000 cubic yards to complete the project.

In executing this work the United States has expended up to June 30, 1890, including $25,000 expended for surveys under the last river and harbor bill, and exclusive of $62,359.80 expended upon the foundation of the Copperas Creek Lock—afterwards completed by the State of Illinois—the sum of $917,190.30. An additional amount of $747,747 was expended by the State of Illinois on Henry and Copperas Creek locks.

During the fiscal year ending June 30, 1890, the following work was done:

(*a*) *La Grange Lock.*—The coffer-dam was pumped out, and the lock cleaned; the lock valve-gearing strengthened; the gates calked and painted; maneuvering platforms and gear placed; the coffer-dam removed and the lock opened to navigation. Guide-piles were driven at head of lock, and a protection levee 1,200 feet in length completed above the lock, and 50,329 cubic yards of dredging done in connection with the completion of the lock and dam. There remains to be done, additional filling behind the land-wall of the lock; pile revetments of banks above and below the lock, and an overhauling of the filling and emptying arrangements of the lock, which are not satisfactory.

(*b*) *La Grange Dam.*—The dam at La Grange Lock was begun August 13, 1889, and completed sufficiently to allow the lock to be opened to navigation October 21, 1889. A rise in the river November 1, 1889, stopped work on the dam and prevented its completion. There remains to be done, 170 linear feet of coping plank to be spiked to the sloping top of the dam, and some additional stone filling in this section; also about 340 linear feet of apron to be built.

(*c*) *Kampsville Lock.*—The delivery of cut stone and backing for this lock continued under contract until all stone contracted for was de-

livered. All of the backing stone, and all of the cut stone for the lock except part of the coping course, and the facing stone for courses M to S, inclusive, has been delivered, as well as all the stone required for the abutment of the dam.

The plant has been repaired and maintained in serviceable condition, but all hulls of dredges, boats, and barges are nearly unserviceable from age and decay.

(*d*) *Survey of water-way between Lake Michigan and the Illinois River, at La Salle, Illinois.*—During the fiscal year the field and office work relating to this survey ordered by Congress in the river and harbor act of August 11, 1888, was continued to completion, and a report thereon, with maps and detailed estimates of cost, rendered February 28, 1890, which has been published as House Ex. Doc. No. 264, Fifty-first Congress, first session.

July 1, 1889, amount available		$73,541.32
July 1, 1889, amount covered by uncompleted contracts		35,369.30
		108,910.62
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$103,698.37	
Reserve for expenses Office Chief of Engineers	179.00	
		103,877.37
July 1, 1890, balance available		5,033.25
Amount appropriated by act of September 19, 1890		200,000.00
Amount available for fiscal year ending June 30, 1891		205,033.25
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		212,500.00

(See Appendix J J 3.)

4. *Operating and care of La Grange Lock.*—This lock has been maintained and operated under the general indefinite appropriation for "Operating and care of canals and other works of navigation," contained in the river and harbor act of July 5, 1884, section 4. The approaches to the lock have been kept dredged, and the lock maintained in serviceable condition. Since its opening, October 21, 1889, 531 lockages have been made. Eleven thousand five hundred and forty-eight cubic yards of the material dredged from the approaches to the lock were deposited behind the land-wall. The amount expended during the fiscal year was $7,176.96.

(See Appendix J J 4.)

5. *Calumet River, Illinois and Indiana.*—The object of this improvement, so far as at present projected, is to secure a channel 200 feet in width, and 16 feet in depth below low-water plane in Lake Michigan, from the mouth of the Calumet River at Calumet Harbor, Illinois, to one-half mile east of Hammond, Ind., with a view to increasing the facilities for handling the growing commerce of this region, and also to aid in providing means for the better accommodation of much of the commerce of Chicago River, which is now very much crowded. The original depth of navigation in this river varied from 6 to 10 feet.

The various acts of Congress, and the limitations made by law upon the expenditure of the appropriation thereby made, are stated in the last annual report Chief of Engineers.

At the beginning of the last fiscal year work was in progress under two contracts with the lowest responsible bidders for dredging, one

"between the mouth and One hundred and eighth street;" the other for the part of the river "between the forks and one-half mile east of Hammond, Ind." Under these contracts during the past fiscal year work has been done as follows:

(*a*) *Between the mouth and One hundredth and eighth street.*—Three hundred and fifty-four thousand and seventeen cubic yards of material have been removed, which, with 24,608 cubic yards dredged but not paid for last year, completed the dredging to the full width of 200 feet; to the depth of 16 feet at low water from the mouth of the river to a point near the first slip of the South Chicago Dock Company, about 1¾ miles above the mouth of the river.

This work has dragged, owing to the difficulties encountered by the contractors in perfecting their plant and disposing of the dredged material.

(*b*) *Between the forks and one-half mile east of Hammond, Indiana.*—The contractors removed 30,303 cubic yards of material, completing their contract, which resulted in obtaining a navigable channel 10 feet in depth throughout the section. This channel, however, has deteriorated, owing to the practice of slaughter-houses of dumping their refuse into the river.

The amount expended by the United States to the close of the fiscal year ending June 30, 1890, is $78,304.42, of which $52,610.67 has been paid for work between the mouth and One hundredth and eighth street, including $5,000 for legal expenses in securing the releases from land-owners required by the river and harbor act of July 5, 1884, and $25,693.75 for work between the forks and one-half mile east of Hammond, Ind.

The funds now on hand will be applied to continuing work under the existing contract, and to forwarding to completion, under further contracts, the approved project.

July 1, 1889, amount available		$6,398.88
July 1, 1889, amount covered by uncompleted contracts		97,939.44
		104,383.32
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$52,532.04	
Reserved for expenses, Office Chief of Engineers	16.00	
July 1, 1890, amount covered by uncompleted contracts extended during fiscal year ending June 30, 1890	49,605.26	
		102,153.30
July 1, 1890, balance available		2,230.02
Amount appropriated by act of September 19, 1890		50,000.00
Amount available for fiscal year ending June 30, 1891		52,230.02
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		820,000.00

(See Appendix J J 5.)

6. *Location of the Illinois and Mississippi Canal.*—This work was directed by the river and harbor act of August 11, 1888, which changed the name of the proposed canal from "Hennepin Canal" to the above.

The work consisted in the location upon maps compiled from former surveys along the "line approved by the Secretary of War" of a canal from the "Illinois River, at or near the town of Hennepin, to the Mis-

sissippi River at or above the mouth of Rock River, together with a necessary feeder for the same," to be "80 feet wide at the water surface, and to have a depth of not less than 7 feet of water, with locks 170 feet long and 30 feet wide;" also, "detailed plans and estimates for the construction of said canal and feeder."

The route approved by the Secretary of War October 27, 1888, is the route known as the Rock Island Route, and the locations, plans, and estimates were prepared for this particular route, *via* Penney's Slough to the mouth of Rock River.

During the past fiscal year work was carried on continuously until June 21, 1890, when it was completed, and a final report submitted, which has been published as House Ex. Doc. No. 429, Fifty-first Congress, first session.

A preliminary report was also submitted March 27, 1890, which has been published as House Ex. Doc. No. 316, Fifty-first Congress, first session.

The work done during the fiscal year embraced:

(1) Further soundings, or rather examinations in the bed of Rock River from Penney's Slough to Milan, and in the vicinity of the head of the feeder at Dixon, Ill., and a survey of Rock River at its mouth.

(2) The completion of an atlas, comprising 77 sheets, showing the location of the route and the detailed plans and estimates for the various constructions necessary to establish the navigation over the route selected, together with one title-page, one sheet of estimates, and one index sheet.

(3) Tracing and blue-printing the sheets of this atlas, and preparing and rendering the preliminary and final reports of the work.

The force has been paid off and disbanded with exception of one draughtsman, who is finishing the retained tracings of the maps as far as the balance of the funds available will allow.

July 1, 1889, amount available	$9.735.83
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	9,583.03
July 1, 1890, balance available	152.80

(See Appendix J J 6.)

IMPROVEMENT OF HARBORS ON THE EASTERN SHORE OF LAKE MICHIGAN.

Officer in charge, Maj. William Ludlow, Corps of Engineers, having under his immediate orders until August 30, 1889, Lieut. J. E. Kuhn, Corps of Engineers; Division Engineer, Col. O. M. Poe, Corps of Engineers.

Unusual conditions affecting navigation have prevailed on Lake Michigan during the past year. The lake has been lower than for thirty years previous, and the high winter temperature prevented the formation of ice and left the surface open and exposed to the full force of the winter gales. The consequent accumulations of shoals and bars at the harbor entrances have been unusually heavy, and the navigation has been much interfered with. The local engineer calls attention to the need of an adequate dredging plant to keep the harbors in navigable condition and reduce the cost of dredging work, which, with a Government plant, costs about half the contract prices.

1. *Charlevoix Harbor and entrance to Pine Lake, Michigan.*—Originally

the entrance was about 75 feet in width, varying in depth from 2 feet to 6 feet. The project of 1868, as later revised, provides for a 12-foot navigation between piers 100 feet to 150 feet apart from Lake Michigan to Round Lake and thence into Pine Lake the same depth, with 83 feet width between revetted banks.

The total expenditure to June 30, 1889, was $80,809.74.

The piers have not yet received their full development, and the accessions of sand from time to time reduce the navigable depth, so that dredging, as at nearly all the harbors, is a frequently recurring need. At the opening of navigation in the spring of 1890 the depth was found to be so little as 8½ feet.

The expenditure for the fiscal year 1890 was $10,954.35.

The three cribs, 50 feet by 20 feet by 18½ feet, for which contract had been made in February, 1889, for the extension of the south pier were completed in August, 1889, adding 150 feet to its length, but still leaving 100 feet more to finish it, according to the present project. The north pier has its full length, and if adequate provision is made for the prompt and timely service of a dredge the 12-foot navigation called for by the project can probably be maintained.

This supposes, however, that the existing works shall, by repair and modification when necessary, be kept in proper condition to perform their intended service and protect the channel.

During the year minor repairs were made to the north pier and the channels were dredged between June 29 and July 16 to a depth of 14 feet, removing 6,300 yards of sand.

July 1, 1889, amount available	$4,094.96
July 1, 1889, amount available to apply on existing contracts	8,595.30
July 1, 1889, total available	12,690.26
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	10,954.35
July 1, 1890, balance available	1,735.91
Amount appropriated by act of September 19, 1890	9,000.00
Amount available for fiscal year ending June 30, 1891	10,735.91
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	83,500.00

(See Appendix K K 1.)

2. *Frankfort Harbor, Michigan.*—The natural channel through the beach between Lakes Aux Becs Scies and Michigan had but 3 or 4 feet of water, and the project of 1866, as later amended, provided for a 12-foot navigation between piers and revetments 200 feet apart.

The expenditure to June 30, 1889, was $247,932.32, with 400 feet of north pier and 100 feet of south pier still to build and some of the older work needing repair.

The expenditure for the fiscal year 1890 was $9,407.20.

Under the contract of February, 1889, two cribs, 50 feet by 24 feet by 22½ feet, were built on the south pier extending it 100 feet, the work being completed in July, 1889.

At the opening of navigation in the spring of 1890, a survey made in April showed that the navigable depth was reduced to 9½ feet, which must be deepened by dredging.

The north pier needs 300 feet and the south pier 100 feet to complete them.

July 1, 1889, amount available	$1,924.45
July 1, 1889, amount available to apply on existing contracts	8,081.58
July 1, 1889, total available	10,006.03
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	9,407.20
July 1, 1890, balance available	598.83
Amount appropriated by act of September 19, 1890	10,000.00
Amount available for fiscal year ending June 30, 1891	10,598.83
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	10,500.00

(See Appendix K K 2.)

3. *Harbor of refuge at Portage Lake, Michigan.*—Portage Lake is a large and deep expanse of water lying about midway between Point Betsey and Big Sable, and separated from Lake Michigan by a narrow sand beach through which the natural outlet was little more than a shallow drain.

The project of 1879 was to provide a harbor of refuge for the security of the general lake commerce by the construction of an entrance into Portage Lake 400 feet in width between piers with a navigable depth of 18 feet.

To June 30, 1889, there had been expended on this project $83,959.95 in seven installments in eleven years.

The expenditure for the past fiscal year was $6,091.86, almost entirely for dredging. Between May and October, 1889, 57,000 cubic yards were taken out to depths varying from 6 to 12 feet, but by December 1 the entrance was found to be rapidly silting up, and in May, 1890, the 12-foot dredged channel had shoaled to 5½ and 7 feet.

July 1, 1889, amount available	$3,558.58
July 1, 1889, amount available to apply on existing contracts	4,981.47
July 1, 1889, total available	8,540.05
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	6,091.86
July 1, 1890, balance available	2,448.19
Amount appropriated by act of September 19, 1890	8,000.00
Amount available for fiscal year ending June 30, 1891	10,448.19
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	167,000.00

(See Appendix K K 3.)

4. *Manistee Harbor, Michigan.*—As originally improved at local expense by the building of rough slab piers, the channel at the mouth of the Manistee River, which is the outlet for Manistee Lake, had 7 or 8 feet of water. The project of 1867, later modified, provided for an increase to 12 feet.

The expenditure to July 1, 1889, $231,837.45, resulted in securing the desired depth with an entrance width of 180 feet, while in the river above, over the distance of 1¼ miles to the city of Manistee, the depth was limited to about 10½ feet. The development of the local commerce has been such as to necessitate enlarging the official project to provide for deepening the navigation to 15 feet, which is the ruling depth of

lake navigation, and extending it entirely through from Lake Michigan to Lake Manistee, whence and to which the shipments are made.

This enlargement of project will involve the extension of the piers into deeper water and the dredging of the inner channel, for which the estimated cost is $115,000.

The expenditure for the past fiscal year was $11,630.41.

Two cribs, 50 feet by 30 feet by 22½ feet, contracted for in February, 1889, were built on the south pier by October, 1889, and minor repairs were made to the north pier.

July 1, 1889, amount available	$6,831.55
July 1, 1889, amount available to apply on existing contracts	9,331.00
July 1, 1889, total available	16,162.55
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	11,630.41
July 1, 1890, balance available	4,532.14
Amount appropriated by act of September 19, 1890	50,000.00
Amount available for fiscal year ending June 30, 1891	54,532.14
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	75,000.00

(See Appendix K K 4.)

5. *Ludington Harbor, Michigan.*—The natural outlet from Pere Marquette Lake into Lake Michigan had a narrow channel of varying depth not exceeding 7 feet.

The project of 1867 was to furnish a 12-foot navigation between piers 200 feet apart. In 1885 the need of a harbor of refuge in this portion of the lake, and the failure of adequate appropriation for the development of the Portage Lake Harbor, which had been designed and under construction for that purpose since 1879, suggested the enlargement of the Ludington Harbor so as to provide an entrance of 400 feet width and 18 feet navigable depth to make it available for general commerce seeking shelter during storms. This plan, requiring the removal of the present south pier and its entire reconstruction 200 feet south of its present position, has been reconsidered because its completion would involve an expenditure of not less than $325,000, not including the original cost of the present south pier, while the Portage Lake project, having otherwise several points of advantage, could be completed for $175,000, and because the balance of appropriation to the credit of Ludington Harbor was sufficient to finish it if the south pier, as built, was retained and extended. Furthermore, there was reason to suppose that the increased width of entrance at Ludington would tend to impair existing wharf and harbor facilities by admitting the sea more freely and that the subsequent maintenance of the greater channel dimensions would involve difficulty and expense.

Contracts have therefore been made providing for the completion of the harbor piers during the ensuing season prior to December, 1890.

The expenditure to July 1, 1889, was $241,491.57, the north pier then lacking 500 feet and the south pier 700 feet of length, in addition to which the older work was in need of repairs.

The expenditure for the past fiscal year was $44,244.64.

Under the contract of February, 1889, ten cribs were added to the north pier by November 19, 1889, and considerable repairs were made to both piers, more particularly with the object of stopping the percolation of sand through them into the channel.

The entrance was dredged in the fall of 1889 and again after the op ing of navigation. March 26, 1890, a supplementary contract was m to provide for the completion of the south pier according to the lat revision of the project. Work began in April, and by July 1 ei cribs had been built.

July 1, 1889, amount available		$55,17
July 1, 1889, amount available to apply on existing contracts		55,76
July 1, 1889, total available		110,94
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$44,112.64	
July 1, 1890, outstanding liabilities	132.00	
July 1, 1890, amount covered by uncompleted contracts made during the fiscal year ending June 30, 1890	55,078.96	
		99,32
July 1, 1890 balance available		11,619

(See Appendix K K 5.)

6. *Pentwater Harbor, Michigan.*—The original channel between Pe water Lake and Lake Michigan, as constructed at local expense, w slab piers, had a width of about 75 feet and a depth of 4 feet.

The project of 1866 proposed increasing the width to 150 feet and navigation to 12 feet.

The expenditure to July 1, 1889, was $214,129.88, the full depth bei from time to time reduced by accessions of sand requiring the use c dredge to remove them.

The expenditure for the past year was $8,822.95. Contract was m in March, 1889, for the construction of a crib 50 feet by 30 feet by feet on the south pier, and completed August, 1889.

The dredging contract of April, 1889, was completed in August, m ing a continuous 12-foot channel between the lakes. Sand fences w built on both sides, and in May, 1890, repairs were begun to the so revetment.

In April, 1890, examination showed that during the winter the trance had shoaled to 7 feet and provision was made for dredging it 13 and 14 feet. This work is now in progress.

The south pier lacks 200 feet of its projected length.

July 1, 1889, amount available		$2,49
July 1, 1889, amount available to apply on existing contracts		9,19
July 1, 1889, total available		11,69
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$8,496.54	
July 1, 1890, outstanding liabilities	326.41	
July 1, 1890, amount covered by uncompleted contracts made during fiscal year ending June 30, 1890	180.00	
		9,00
July 1, 1890, balance available		2,68
Amount appropriated by act of September 19, 1890		8,00
Amount available for fiscal year ending June 30, 1891		10,68
Amount (estimated) required for completion of existing project Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		29,00

(See Appendix K K 6.)

7. *White River Harbor, Michigan.*—The natural outlet from Wh Lake into Lake Michigan was barely navigable. Local interests h sought to improve it by slab piers and obtained 5 feet depth.

The project of 1866 sought to deepen the navigation to 12 feet between piers 200 feet apart.

The expenditure to July 1, 1889 was $249,449.62.

The piers are not yet fully developed, and the constant accessions of sand render dredging necessary every year.

The expenditure for the past fiscal year was $3,036.95, for sand fences, dredging, and repairs. In April, 1890, the entrance was found silted, so that not over 10 feet could be carried in through a narrow lead, and in June one of the Government dredges was sent there to open it.

The north pier lacks 250 feet of its proposed extension and the south pier 200 feet.

July 1, 1889, amount available		$4,274.92
July 1, 1889, amount available to apply on existing contracts		3,826.46
July 1, 1889, total available		8,101.38
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$2,608.30	
July 1, 1890, outstanding liabilities	428.65	
July 1, 1890, amount covered by uncompleted contracts made during the fiscal year ending June 30, 1890	300.00	
		3,336.95
July 1, 1890, balance available		4,764.43
Amount appropriated by act of September 19, 1890		17,000.00
Amount available for fiscal year ending June 30, 1891		21,764.43
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		48,225.00

(See Appendix K K 7.)

8. *Muskegon Harbor, Michigan.*—The mouth of the Muskegon River, discharging through Muskegon Lake into Lake Michigan, prior to 1866 had been deepened by slab piers to 13 feet, but with a bar in front with not over 7 feet. The official project was to widen the entrance from 175 to 300 feet and deepen the navigation to about 13 feet by the extension of piers into the lake.

The amount expended to July 1, 1889, was $236,545.80. The south pier was not completed, but 13½ feet could be carried in. A gap of 80 feet exists in the north pier, between the old and new portions, which should be closed.

The expenditure for the past year was $35,705.43. The five cribs, 50 feet by 30 feet by 24½ feet, covered by the contract of February, 1889, were completed in September, adding 250 feet to the south pier and leaving 150 feet yet to build. Repairs were made to the older portions of both piers in 1889 and continued during the present season.

In April, 1890, examination showed that the entrance was obstructed by a shoal with 12 feet upon it, and the Government dredge was sent in May to remove it to a depth of 16 feet. This, as well as the repair work, is still in progress.

July 1, 1889, amount available		$15,838.21
July 1, 1889, amount available to apply on existing contracts		26,615.99
July 1, 1889, total available		42,454.20
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$34,244.90	
July 1, 1890, outstanding liabilities	1,460.53	
		35,705.43
July 1, 1890, balance available		6,748.77
Amount appropriated by act of September 19, 1890		50,000.00
Amount available for fiscal year ending *June 30, 1891*		56,748.77

Amount (estimated) required for completion of existing project	$31,075.
Submitted in compliance with requirements of sections 2 or river and harbor acts of 1866 and 1867.	

(See Appendix K K 8.)

9. *Grand Haven Harbor, Michigan.*—Grand Haven, in addition to it local commerce, has a special importance as the main harbor of refug on the east coast of Lake Michigan.

The large volume of Grand River, which naturally maintains a chan nel of favorable capacity, has enabled the official project of 1866 to provide for an entrance width of 400 feet and a depth of 18 feet dimen sions which render the harbor suitable to the shelter of shipping in stormy weather.

The expenditure to July 1, 1889, was $521,237.83. The harbor works, though of considerable extent, are still far from completion, and the delay in advancing them to deep water in the lake, together with the accessions of sand from the banks and dunes inside the entrance, have been the cause of occasional difficulty from the formation of a bar a the mouth, and much increased the ultimate cost of construction an maintenance.

The expenditure for the past year was $25,616.08.

Under the contract of February, 1889, three cribs 50 feet by 30 feet b 26½ feet were added to the north pier by September, 1889. The sout revetment was repaired, sand fences built, and willow cuttings plante to arrest sand drift.

In December, 1889, owing to the abnormal low level of the lake an the open winter, the outer bar had risen to 11 or 12 feet depth and ex tended northward and southward so as to cross the prolongation of th piers, leaving channels of 16 to 19 feet on each side. Had the develop ment of the shoal continued the danger of entering would have becom too serious to risk in boisterous weather, but later it was found, as th lake rose somewhat and the volume of the river strengthened, that th bar was cut down.

For the completion of the harbor facilities, which are of both loc and general importance, the piers should be extended for a distanc respectively of 550 feet and 650 feet, the north shore revetment shoul be prolonged upward, and the sand movements in the vicinity of th stream be controlled.

July 1, 1889, amount available		$8,481.2
July 1, 1889, amount available to apply on existing contracts		19,647.0
July 1, 1889, total available		28,128.3
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$25,473.68	
July 1, 1890, outstanding liabilities	142.40	
		25,616.0
July 1, 1890, balance available		2,512.
Amount appropriated by act of September 19, 1890		75,000.
Amount available for fiscal year ending June 30, 1891		77,512.
Amount (estimated) required for completion of existing project		125,000
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix K K 9.)

10. *Black Lake Harbor Michigan.*—In 1866, when the United States assumed charge of the improvement, the outlet intoLake Michigan from Black Lake had been opened by the local interests and revetted with brush-mattress and cribs, with the result of securing not to exceed 5 feet of navigable depth. In fact, in this case, as in all similar ones, the absence of any considerable outflowing current reduces the question to one of dredging, supplemented by piers to protect the deepened channel. The Government project sought to provide a 12-foot navigation with piers 200 feet apart, and to July 1, 1889, the expenditure was $264,143.84, with results that would have been quite satisfactory had adequate provision been made for the maintenance of the works and the frequent dredging needful to remove the recurring accumulations of sand between the piers.

The expenditure for the past year was $444.26, all for dredging. In July, 1889, the entrance was practically closed to navigation, and the balance to the credit of the harbor being insufficient, additional funds were subscribed by the citizens of Holland to complete the cut. At the opening of navigation in 1890 the same conditions existed and the Holland people paid for the use of the dredge, making a channel 25 feet wide and 13 feet deep.

July 1, 1889, amount available	$471.47
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	444.26
July 1, 1890, balance available	27.21
Amount appropriated by act of September 19, 1890	10,000.00
Amount available for fiscal year ending June 30, 1891	10,027.21

(See Appendix K K 10.)

11. *Saugatuck Harbor, Michigan.*—The Kalamazoo River is a stream of considerable natural capacity, and maintains a channel of 7 or 8 feet by aid of the incomplete and partly dismantled works at the entrance built under the project of 1867, which was intended to provide a navigable depth of 10 feet. Since 1875, however, in the absence of appropriation, construction work has practically been suspended.

The expenditures to July 1, 1889, were $134,998.88, and for the past year $5,257.95, of which $2,000 was for dredging and $2,700 for materials for repairs, which the district engineer has not deemed it expedient to use.

In August, 1889, the entrance outside the pier was obstructed, and the Government dredge was sent to open it.

In May, 1890, a shoal had formed inside the river above the revetments, and was dredged to permit the passage of the vessels which still trade to the locality.

July 1, 1889, amount available	$3,568.42
July 1, 1889, amount available to apply on existing contracts	1,871.70
July 1, 1889, total available	5,440.12
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	5,257.95
July 1, 1890, balance available	182.17

(See Appendix K K 11.)

12. *South Haven Harbor, Michigan.*—The earlier improvement of the mouth of Black River at local expense had made an entrance 85 feet in width and about 7 feet deep. The project of 1866 provided for an entrance of 12 feet depth and 180 feet width. The expenditure to July 1, 1889, was $183,147.27 with good results, but the tendency to shoaling between the piers renders frequent dredging necessary.

The expenditure for the past year was $8,472.47. Repairs were made to the outer crib of the north pier and to a portion of the south pier, and sand fences were built. The Government dredge took out 25,000 cubic yards between the entrance and the highway bridge in the fall of 1889, deepening the channel to 13 feet, and at the cost of the citizens dug a winding basin near the upper end of the harbor.

In April, 1890, a bar was found across the entrance with not over 8½ feet upon it, and in May the dredge re-opened this to 13 feet. Thence to South Haven the channel depth was found to be 11½ feet.

The north pier lacks 150 feet and the south pier 200 feet of completion.

July 1, 1889, amount available		3,015.65
July 1, 1889. amount available to apply on existing contracts		5,837.08
July 1, 1889, total available		8,852.73
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	8,447.47	
July 1, 1890, outstanding liabilities	25.00	
		8,472.47
July 1, 1890, balance available		380.26
Amount appropriated by act of September 19, 1890		15,000.00
Amount available for fiscal year ending June 30, 1891		15,380.26
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		6,500.00

(See Appendix K K 12.)

13. *St. Joseph Harbor, Michigan.*—The original outflow from St. Joseph River was across the open beach with a shifting channel varying in depth from 3 to 7 feet.

The improvement of the entrance was begun by the United States in 1836, the locality being selected for the construction of a harbor of refuge for the lake commerce. The project provided for an entrance depth of 16 feet between piers about 270 feet apart. Later the improvement of the inner harbor was begun by the construction of a training dike at its upper end, and in 1880 the United States assumed charge of the canal, which had been built by authority of the State to connect Benton Harbor with St. Joseph Harbor.

Since 1870, when the Chicago and Michigan Lake Shore Railroad built a trestle bridge across the harbor near the mouth it has ceased to be of general use as a harbor of refuge, but the local commerce has continued to develop.

The expenditure to July 1, 1889, was $347,906.34. The depth between the pier is usually sufficient, a bar of 15 feet outside in the lake limiting the draught to that amount.

For the past year the expenditure was $6,151.71.

Under the contract of April, 1889, the wing to connect the east end

of the north pier with the shore was completed in August. In November partial repairs were made to some dangerous places in the north pier, and in December the dredge worked in the canal until January 23. In April, 1890, the dredging was renewed, cutting through a shoal near the entrance and deepening the canal to 13 feet. The winding basin at Benton Harbor was also enlarged and deepened.

During the winter the dredging plant was repaired.

In May, 1890, the entrance depth was not less than 15 feet and thence to Benton Harbor not less than 12 feet.

July 1, 1889, amount available	$3,311.44
July 1, 1889, amount available to apply on existing contracts	2,895.22
July 1, 1889, total available	6,206.66
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	6,151.71
July 1, 1890, balance available	54.95
Amount appropriated by act of September 19, 1890	20,000.00
Amount available for fiscal year ending June 30, 1891	20,054.95

(See Appendix K K 13.)

14. *St. Joseph River, Michigan.*—For the removal of obstructions in St. Joseph River between St. Joseph and Berrien Springs, a distance of 25 miles, a small snagging plant was procured, and the worst places treated by the removal of logs and bowlders and the construction of small wing-dams at three points, to reduce its low-water channel width. The expenditure on this account during the past year was $1,326.52, and the work will be continued during the ensuing season.

July 1, 1889, amount available	$2,233.52
July 1, 1889, amount available to apply on existing contracts	250.00
July 1, 1889, total available	2,483.52
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,326.52
July 1, 1890, balance available	1,157.00
Amount appropriated by act of September 19, 1890	1,000.00
Amount available for fiscal year ending June 30, 1891	2,157.00

(See Appendix K K 14.)

15. *Michigan City Harbor, Indiana.—Outer Harbor.*—The outer harbor consists of an inclosed area in the lake, projected in 1870 and completed fourteen years later. This work is not available as a harbor of refuge, for which it was intended, by reason of its lack of depth, the narrowness of the entrance (215 feet) and the exposure of the opening at the northwest angle to the heavy seas out of the lake from the northwest quarter.

The outer breakwater, projected in 1883 and the construction of which was begun last year, lies, as now designed, detached from the other works, beginning 400 feet to the westward and thence extending 2,000 feet, with an angle of 135° at the middle point.

The expenditure to July 1, 1889, for the construction of the works comprising the "outer harbor" has been $576,525.58, and during the past fiscal year $72,182.30. Under the contract made in March, 1889, three cribs were built in the breakwater pier at the east side of the entrance

and ten cribs in the outer breakwater, the work being continued December 25, 1889.

This spring the building up of the breakwater pier cribs to the f height was begun, and by July the work was well under way. T dredging plant was repaired during the winter.

July 1, 1889, amount available		$35,497
July 1, 1889, amount available to apply on existing contracts		57,352
July 1, 1889, total available		92,849
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$71,596.53	
July 1, 1890, outstanding liabilities	585.77	
July 1, 1890, amount covered by uncompleted contracts made during the fiscal year ending June 30, 1890	2,260.69	
		74,442
July 1, 1890, balance available		18,406
Amount appropriated by act of September 19, 1890		50,000
Amount available for fiscal year ending June 30, 1891		68,406
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		279,613

(See Appendix K K 15.)

Inner harbor.—The inner harbor at Michigan City, where the sh ping business is done, and which practically furnishes all the hart facilities that are of service, has been under improvement by the Unit States since 1836, under a project for dredging and revetting the cre channel and protecting the entrance by piers.

In 1866 the harbor was re-examined and found in need of conside ble extension and repairs. The expenditures prior to that date h amounted to $156,000, and Congress renewed the appropriations for t work when it was shown that the local authorities had expended, i cluding the cost of a dredge, $100,000 for the purpose. From 1866 June 30, 1889, the expenditure has been $99,202.16, and for the pa year $2,480.33.

The dredging has been carried nearly 1½ miles up the creek, the desi nated limit of the improvement being the Wabash, St. Louis and Paci Railroad bridge at that point. The dredging was continued to Augu 14, 1889, making a channel 60 feet wide and 13 feet deep.

July 1, 1889, amount available	$2,672
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	2,480
July 1, 1890, balance available	192
Amount appropriated by act of September 19, 1890	7,500
Amount available for fiscal year ending June 30, 1891	7,692

(See Appendix K K 15.)

EXAMINATION AND SURVEY FOR IMPROVEMENT, TO COMPLY WI REQUIREMENTS OF THE RIVER AND HARBOR ACT OF AUGUST 1 1888.

It appearing from the preliminary examination made by the loc engineer of *Petoskey Harbor, Michigan, for breakwater and harbor refuge,* that the locality is worthy of improvement, and the publ

necessity therefor being apparent from the facts and reasons reported, which are concurred in by the Chief of Engineers, Major Ludlow was charged with and completed its survey, the results of which were transmitted to Congress and printed as House Ex. Doc. 107, Fifty-first Congress, first session. (See also Appendix K K 16.)

IMPROVEMENT OF ST. MARY'S RIVER—ENLARGEMENT OF AND OPERATING ST. MARY'S FALLS CANAL—CONSTRUCTION OF HARBOR OF REFUGE ON LAKE HURON, AND IMPROVEMENT OF CERTAIN HARBORS ON LAKE HURON AND OF SAGINAW RIVER—PRESERVATION OF AND OPERATING ST. CLAIR FLATS CANAL—IMPROVEMENT OF GROSSE POINT CHANNEL AND OF DETROIT, CLINTON, ROUGE, AND BLACK RIVERS.

Officer in charge, Col. O. M. Poe, Corps of Engineers, with Lieut. C. C. S. Riché, Corps of Engineers, under his immediate orders during the entire year, and with Lieut. H. F. Hodges, Corps of Engineers, under his immediate orders since June 24, 1890.

1. *St. Mary's River, Michigan.*—The project for obtaining a navigable channel of 16 feet depth between Lakes Superior and Huron had been barely completed when the demands of commerce so enormously increased that the work of obtaining a depth of 20 feet throughout was undertaken, with the full sanction of both legislative and executive authority.

A necessary part of the project is the construction of a new lock upon the site of the old State locks, to have a length of 800 feet between gates, a width of 100 feet throughout, a depth of 21 feet on the miter-sills, and a single lift approximating 18 feet. The canal is to be deepened to correspond. The estimated cost of this enlargement of the canal system is $4,738,865, for the details of which see pages 2220 *et seq.* of the Annual Report of the Chief of Engineers for 1887. The cofferdam surrounding the site of the new lock-pit is completed, and the pumping plant is all in position; the pier in front of Fort Brady is completed, and 30,239 cubic yards of material removed from the lock-pit have been placed behind it; and work is being continued under the contract for excavating the lock-pit, 105,850 cubic yards of earth and 9,956 cubic yards of stone having been removed from the lock-pit, and 4,961 cubic yards of stone from the walls of the lock of 1855 having been piled on the canal-pier since the beginning of operations. (These figures are for work done up to May 31, 1890.)

The statistics of the commerce of the canal indicate more clearly each succeeding year the urgency for rapid progress in the improvement. The report for operating and care of the canal for the past fiscal year clearly shows that the limit of its capacity is being rapidly approached, 10,108 vessels, 8,288,580 tons of freight, and 24,125 passengers having been carried through it during that time.

The necessity for the early completion of the improvement is so great that an estimate of $1,236,000 is submitted for the prosecution of the work during the fiscal year ending June 30, 1892, in full confidence that the actual conditions now existing will amply justify so large an appropriation.

The aggregate expended on this work to June 30, 1889, was	$250,331.52
The amount expended during the fiscal year ending June 30, 1890, was	148,694.54
Total expenditure to June 30, 1890	399,026.06

July 1, 1889, amount available		$74
July 1, 1889, amount covered by existing contracts		25
		99
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$140,280.70	
July 1, 1890, outstanding liabilities	8,413.84	
July 1, 1890, amount covered by uncompleted contracts June 30, 1890	156,336.59	
		30
July 1, 1890, balance available		69
Amount appropriated by act of September 19, 1890		90
Amount available for fiscal year ending June 30, 1891		1,59
Amount (estimated) required for completion of existing project		2,83
Amount that can be profitably expended in fiscal year ending June 30, 1892		1,23

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix L L 1.)

2. *Operating and care of St. Mary's Falls Canal, Michigan.*—I the fiscal year the canal was open to navigation two hundred and t nine days. It was closed for the winter December 4, 1889, and April 20 for the season of 1890.

Ten thousand one hundred and eight vessels, etc., repres 7,899,604 registered tons, and carrying 8,288,580 tons of freig 24,125 passengers, passed through the canal in 4,859 lockages.

The staple articles transported were 1,894,433 tons of coal, tons of copper, 2,592,736 barrels of flour, 22,192,494 bushels of 4,404,935 tons of iron ore, 72,163 tons of pig and manufacture 207,762 barrels of salt, 5,905 tons of silver ore, 308,032,000 feet B lumber, 40,829 tons of building stone, 2,597 tons of wool, 455 hides, and 344,425 tons of miscellaneous and unclassified freight

The expenditures on account of operating and care for the fisc aggregated $37,237.08.

The estimated amount required for the fiscal year ending J 1891, is $48,000, all of which is already provided for by indefin propriation.

Aggregate expended on this improvement to June 30, 1889, was	$23
Amount expended during fiscal year ending June 30, 1890	3
Total expenditure to June 30, 1890	27
Amount required for fiscal year ending June 30, 1891	4
Balance remaining from allotment of preceding year, exclusive of outstanding liabilities	
Additional allotment required for fiscal year ending June 30, 1891	3

(See Appendix L L 2.)

3. *Dry-Dock at St. Mary's Falls Canal, Michigan.*—The proposi locate a dry-dock in immediate proximity to the lockage syste objectionable as ever; but if it should be decided to do so, then cation heretofore referred to, at the eastern end of the area tran from the Fort Brady military reservation to the canal reservation least objectionable.

But the construction of a pier in front of the Fort Brady rese has now advanced beyond the point where a dry-dock should be l and a portion of this work would have to be removed, thus inc

by $20,000 the probable cost of a dry-dock, and the estimate therefor should be increased accordingly.

Amount (estimated) required for the construction of a dry-dock at the point indicated, $343,872.

It is understood that the State of Michigan holds $65,000 in readiness to transfer to the United States for the purpose of constructing a dry-dock at St. Mary's Falls Canal.

(See Appendix L L 3.)

4. *Hay Lake Channel, St. Mary's River, Michigan.*—Before improvements were commenced the channel through Hay Lake was restricted in depth at Sugar Island Rapids and at the Middle Neebish; at these two places a maximum draught of but 8 or 9 feet could be carried if a very irregular course was taken, and, practically, vessels drawing more than 6 feet of water would not attempt the passage. In addition to the places above mentioned there were some shoals in Hay Lake requiring removal to make the channel available for the vessels navigating the St. Mary's River.

The original estimates for this improvement were based upon a project for a channel 300 feet wide and 17 feet deep, leaving the present navigable channel of St. Mary's River at Sugar Island Rapids (about 2½ miles below the canal), through these into Hay Lake, and then, by way of the Middle Neebish, rejoining the present navigable channel at the foot of Sugar Island, thus saving a distance of 11 miles and obtaining a route which can be so marked by lights as to be navigable at night—a condition impracticable with the present channel, except by the use of many lights.

The estimated cost of this project was $2,127,292. The project was subsequently modified to increase the depth to 20 feet, the estimated cost being $2,659,115, subject to change, however, in case unexpected difficulties are developed during the progress of the work.

The work under way at Middle Neebish is progressing well. During the year from June 1, 1889, to May 31, 1890, 78,011 cubic yards, bank measure, were excavated by the contractors, Messrs. Dunbar & Sullivan, and about 1,650 linear feet of dike built during the same time.

The length of the route is sufficient to admit of the use of a very extensive plant. An estimate of $500,000 is sufficient, one-half to be applied at Middle Neebish and the other half at Sugar Island Rapids, where right of way has been obtained.

The aggregate expended on this improvement to June 30, 1889, was ...		$497,768.48
The amount expended during the fiscal year ending June 30, 1890, was.		159,547.40
Total expenditures to June 30, 1890		657,315.88
July 1, 1889, amount available		190,001.49
July 1, 1889, amount covered by existing contracts		287,361.68
		477,363.17
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$143,296.47	
July 1, 1890, outstanding liabilities	16,250.93	
July 1, 1890, amount covered by uncompleted contracts June 30, 1890	144,766.47	
		304,313.87
July 1, 1890, balance available		173,049.30
Amount appropriated by act of September 19, 1890		400,000.00
Amount available for fiscal year ending June 30, 1891		573,049.30

Amount (estimated) required for completion of existing project	$1,284,
Amount that can be profitably expended in fiscal year ending June 30, 1892	500,
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix L L 4.)

5. *Harbor at Cheboygan, Michigan.*—Prior to undertaking any imp ment at this harbor, only 6½ to 7 feet of water could be carried a the bar at the mouth of Cheboygan River.

The original project for the improvement, adopted in 1871, con plated dredging a channel 200 feet wide and 14 feet deep througl bar, and revetting each side by a pile-pier. Experience gained du the progress of the work already done leads to the belief that the can be omitted with consequent reduction of cost to the extent of a one-half the original estimate.

Subsequent modifications of the project were made until, as it stands, it provides for a channel of 15 feet in depth, and generally feet in width from the 15-foot curve in the Straits of Mackinac to State Road Bridge.

Up to June 30, 1889, an aggregate of $123,982.71 had been exper on this harbor, and some dredging still remained to be done to comp the project.

During the year ending June 30, 1890, 31,204 cubic yards of mate scow measurement, were excavated, and $5,665.62 expended, and contract closed November 29, 1889, owing to completion of the pro

The result of this dredging has been to make a channel 15 fe depth and 200 feet in width, narrowing to a width of 175 feet in upper part, from the Straits of Mackinac to the State Road Brid Cheboygan.

Until the dredged channel begins to silt up, or the revetting contemplated in the original project of 1871 are shown to be neces no further work is proposed, and therefore no further estimate is mitted at this time.

The aggregate expended on this harbor to June 30, 1889, was	$123,9
The amount expended during the fiscal year ending June 30, 1890, was	5,6
Total expenditure to June 30, 1890	129,6
July 1, 1889, amount available	15,
July 1, 1889, amount covered by existing contracts	9,
	24,
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	5,
July 1, 1890, balance available	18,

(See Appendix L L 5.)

6. *Harbor at Thunder Bay, Michigan.*—Prior to the commenceme the improvement there was a navigable channel from the bay into river of 12 feet depth, and a variable width, at one place only 50 The original project for the improvement of this harbor was ado in 1876, the object being to obtain an entrance channel from the into the river of navigable width, and of not less than 13 feet in d

The project was subsequently modified to such an extent as to vide for a depth of 14 feet.

This had been practically accomplished at the date of the Annua port for 1884. It was then stated that the improvement was of su *character* that it would require attention from time to time, and it

recommended that sufficient appropriation be made to render available the sum of $10,000 for use when it should be wanted. This was not done and the matter remained in abeyance.

Complaints of insufficiency of water arose from three causes.

(1) Deterioriation of depth (due to deposit).

(2) A low stage of water in Lake Huron.

(3) The general use of larger vessels.

The river and harbor act of August 11, 1888, required the expenditure of the balance avilable ($4,514.11), for dredging, and a contract for this dredging was entered into and 5,290 cubic yards excavated up to June 30, 1889, at a cost of $2,232.74, making the aggregate expended on this harbor up to that time $16,667.10.

During the fiscal year ending June 30, 1890, 5,254 cubic yards were excavated and $2,221.60 expended (or a total 10,544 cubic yards excavated under this contract and $4,454.32 expended).

The result of this dredging has been to give a channel 80 feet wide and 14 feet deep across the bar at the mouth of the river, and a clear depth of 13 feet thence to about 1,800 feet above the Second Street Swing Bridge in Alpena.

The aggregate expended on this harbor to June 30, 1889, was	$16,667.10
The amount expended during the fiscal year ending June 30, 1890, was	2,221.60
Total expenditure to June 30, 1890	18,888.70
July 1, 1889, amount available, but covered by existing contracts	2,281.39
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	2,221.60
July 1, 1890, balance available	59.79
Amount appropriated by act of September 19, 1890	5,500.00
Amount available for fiscal year ending June 30, 1891	5,559.79

(See Appendix L L 6.)

7. *Harbor at Au Sable, Michigan.*—Before the beginning of improvements, the mouth of Au Sable River was 150 feet wide, with a depth of 5 feet over the bar. Above the mouth for a quarter of a mile 7 to 10 feet of water was found, and above this point only 5 or 6 feet.

The present project for the improvement of the harbor was adopted in 1866 and modified in 1879, the object being to obtain a channel of not less than 10 feet in depth for a width of 100 feet from Lake Huron to the State Road Bridge at Au Sable.

The aggregate expended on this harbor to June 30, 1889, was $109,160.59 and the works constructed in former years were in much the same condition as reported in the Report of the Chief of Engineers for 1888, page 1962.

By the river and harbor act of August 11, 1888, it was directed that the "balance available from former appropriations shall be expended in dredging at the mouth of Au Sable River."

The balance available was $4,848.97, and to carry into effect this provision it was decided to dredge a channel, having a minimum width of 60 feet (two dredge cuts) and depth of 10 feet, across the bar at the mouth of Au Sable River, a distance of about 1,200 feet, and to remove some minor shoals in the river channel above the bar. This being done, to then apply any balance that might remain to widening the channel across the bar, the object being to secure a navigable depth of 10 feet for such width as the available funds would suffice to pay for.

After due advertisement a contract was awarded on June 28, 1889, to Messrs. Carkin, Stickney & Cram, and dredging was carried on

by them during parts of August and September, 1889; $4,621.48 was expended during the year ending June 30, 1890 ($26.94 of the balance available having been expended prior to June 30, 1889), and 12,864 cubic yards of material, scow measurement, excavated, resulting in a temporary channel, 10 feet in depth, from the mouth of the river to the Au Sable Swing Bridge, having a width of 120 feet across the bar.

The aggregate expended on this harbor to June 30, 1889, was	$109,160.59
The amount expended during the fiscal year ending June 30, 1890, was	4,621.48
Total expended to June 30, 1890	113,782.07
July 1, 1889, amount available, but covered by existing contracts	4,822.03
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	4,621.48
July 1, 1890, balance available	200.55

(See Appendix L L 7.)

8. *Saginaw River Michigan.*—Immediately preceding the formation of any project for the improvement of Saginaw River, its condition was as follows:

The entrance to the river was obstructed by a bar in Saginaw Bay about 1 mile from shore and a half mile in width between the 10-foot curves, with a minimum depth of about 9 feet. Between the mouth of the river and Bay City, a distance of about 5 miles, the depth varied from 15 to 30 feet. Thence to the head of the river, a distance of about 16 miles, the channel was obstructed by a number of bars having only 7 feet of water, thus limiting the navigable depth to about 7 feet, although the prevailing depth varied between 12 and 20 feet.

The original project for the improvement of the river was made in 1866, and only contemplated a straight channel 195 feet wide and 12 feet deep across the bar at the mouth, to be obtained by sufficient dredging. This was completed in 1869, the length of the channel being 6,800 feet.

In 1874 a project for improving the river above Bay City was adopted. It included dredging a 10-foot channel across the bars at East Saginaw and Carrollton, and the construction of a pile revetment along one side of the new channel at the latter place. To this were added in 1876 projects for similar improvements at Zilwaukie Bar and New York Works Bar, and in 1879 at Willow Island.

Under these several projects work slowly progressed until 1881. In 1882 a Board of Engineers considered the subject of the general improvement of Saginaw River, and recommended that the channel be made 200 feet wide, with a depth of 14 feet from Saginaw Bay to Bay City and of 12 feet thence to the head of the river, a total distance of about 23 miles.

The details of the project are given at pages 1863 *et seq.* of the Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1883.

An addition to the project has been made, providing for the repair and extension of the revetment confining the Carrollton Channel and the construction of similar works at the head of Crow Island for the improvement of Zilwaukie Bar, and another addition was made to the project on July 29, 1889, providing for the reconstruction of about 2,615 linear feet of the pile revetment opposite Carrollton Bar in order to render this revetment less liable to ignition.

By the river and harbor act of August 5, 1886, the improvement of the west channel along West Bay City was also added to the project.

Up to June 30, 1889, $439,596.02 had been expended on the work, and at that time a maximum draught of 12 feet could be carried entirely across the bar at the mouth of the river, although the greater portion of the crest of the bar had been dredged to a depth of 14 feet, and from Bay City to Saginaw the navigation was limited to a depth of 9 or 10 feet by various shoals, although the average depth was much greater.

During the year ending June 30, 1890, $49,136.41 was expended and the following progress made on the various works:

Bar at mouth of river.—Cut No. 4 east of the axis of the channel was extended 2,800 feet with width of 30 feet and depth of 14 feet. Cut No. 3, east of the axis, was extended 2,666 feet with same width and depth, and in all 26,312 cubic yards, scow measurement, removed at the contract price of 49 cents per cubic yard.

West Channel, along West Bay City.—The quantity of material removed was 34,021 cubic yards, scow measurement, at the contract price of 28 cents per cubic yard.

Above Bay City.—The pile revetment which forms the easterly boundary of the Carrollton Channel was extended down-stream 1,145 feet. About 855 linear feet that had been left in a more or less incomplete condition at the close of the season of 1887 was entirely finished. About 3,000 linear feet of the old revetment, including the shore-arm, was reconstructed to render it less liable to ignition; the structure was reduced in height 4 feet 3 inches and the top covered with clay and gravel. This completed the revetment at Carrollton.

The plank-beam training-wall along the west side of the Carrollton Channel was extended down-stream 1,134.7 feet, a log chute 32 feet wide being made at the junction of the new and old work, and the beam-wall completed in accordance with the project. Dredging was done to prepare a level foundation for the beam-wall extension, and one dredge cut to a depth of 12 feet was also made in the axis of the channel opposite the lower end of the beam-wall. The total amount dredged was 7,507 cubic yards, scow measurement, at the contract price of 43 cents per cubic yard.

All the new material used was furnished in place by contract. The reconstruction of the old revetment was done by hired labor.

Surveys of the river channel at various shoals and of the bar at the mouth were projected for the past winter, but, owing to lack of ice to support the sounding parties, were unavoidably postponed.

The aggregate expended on this improvement to June 30, 1889, was	$439,596.02
The amount expended during the fiscal year ending June 30, 1890, was..	49,136.41
Total expenditure to June 30, 1890	488,732.43
July 1, 1889, amount available, but covered by existing contracts	53,679.45
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	49,136.41
July 1, 1890, balance available	4,543.04
Amount appropriated by act of September 19, 1890	75,000.00
Amount available for fiscal year ending June 30, 1891	79,543.04
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	162,250.00

(See Appendix L L 8.)

9. *Harbor of refuge at Sand Beach, Lake Huron, Michigan.*—Prior to 1876, vessels, when caught in heavy weather near the dangerous Pointe aux Barques, the southerly headland of the south of Saginaw Bay, were

compelled to run a distance of 60 miles and find refuge in St. Clair River.

After the subsidence of the storm those upward bound had to work their way back again.

The project for the construction of a harbor of refuge at Sand Beach was adopted in 1873, and consisted of a breakwater constructed of timber cribs, filled with stone, inclosing an area which is to be deepened by dredging where necessary.

The estimate of the probable cost of the improvement was $1,442,500. The sum of $1,125,000 was appropriated for the work, and it was practically completed in 1885 at a cost of about $975,000. Few improvements have resulted in greater benefit to the lake commerce, as is fully shown by the infrequency of disasters in the vicinity since it became available.

During the fiscal year ending June 30, 1890, repairs were made to the piers and superstructure where injured by storms; the work was done by hired labor, using materials on hand and those purchased by contract; the Government steam-launch used at the harbor was lengthened and repaired at Detroit, greatly improving her as to strength, speed, and appearance; and a survey of the harbor is now in progress to locate the places to be dredged during the current season.

The superstructure of the piers, especially that of the west pier, is in a bad condition, and while the frequent repairs and renewals of timber and plank give the whole an appearance of strength and solidity, age and decay have partially or wholly destroyed many interior timbers which can not be removed without tearing down the entire superstructure, and which are not even discovered until a severe storm lays them open for inspection.

There is no doubt, therefore, that the present timber superstructure will continue to suffer more and more each succeeding year, and that the annual cost of its repair will steadily increase. For this reason, the next appropriation, if sufficient in amount, should be expended in beginning the construction of a superstructure of concrete or other permanent material; part of the appropriation to be expended for current repairs, for custody and control of the harbor, and for dredging in and around the harbor.

During the fiscal year ending June 30, 1890, 1,494 vessels, having an aggregate of 488,553.61 tons, took refuge in the harbor, showing that it is well worthy the sum asked for its preservation.

The aggregate expended on this harbor to June 30, 1889, was		$1,055,586.94
The amount expended during the fiscal year ending June 30, 1890, was		20,636.50
Total expenditures to June 30, 1890		1,076,223.44
July 1, 1889, amount available		57,484.87
July 1, 1889, amount covered by existing contracts		7,158.42
		64,643.29
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$19,396.94	
July 1, 1890, outstanding liabilities	1,239.56	
July 1, 1890, amount covered by uncompleted contracts made during the fiscal year ending June 30, 1890	17,415.01	
		38,051.51
July 1, 1890, balance available		26,591.78
Amount appropriated by act September 19, 1890		30,000.00
Amount available for fiscal year ending June 30, 1891		56,591.78

(See Appendix L L 9.)

10. *Mouth of Black River, Michigan.*—Black River empties into St. Clair River at Port Huron, Mich. At and below its mouth, extending beyond the middle of St. Clair River, there is a bar or middle-ground which was dredged by the Government, under former appropriations, to a clear depth of 15 feet. The main channel of St. Clair River is found between the middle-ground and the Canadian shore.

By the deposit of material brought down by the current of Black River, the depth of this bar had been reduced an average of about 6 inches, and in conjunction with a low stage of water had become an impediment to navigation along the front of the city in the vicinity of the mouth of Black River.

By the river and harbor act of August 11, 1888, the sum of $10,000 was appropriated for "improving mouth of Black River, Mich."

A project for its expenditure was approved March 6, 1889, and is the present approved project.

This project contemplates making a series of dredge cuts of a uniform depth of 16 feet, along the dock front of Port Huron, from the 16-foot curve above, to the same curve below the mouth of Black River, the first cut at a distance of about 50 feet from the wharves and the others to continue the work outward as far as the funds would permit.

On April 25, 1889, after due advertisement for proposals, the contract for dredging was awarded to Mr. William Richardson, the lowest bidder, at 20 cents per cubic yard, measured in the scows.

The dredging began May 7, 1889, and by June 30, 1889, 20,800 cubic yards had been removed at a cost of $4,413.02, giving a channel across the obstruction 16 feet deep and of sufficient width for careful navigation.

During the year ending June 30, 1890, $5,385.72 have been expended and 25,439 cubic yards removed, giving a channel of 16 feet clear depth from the 16-foot curve above the mouth of the river to the same curve below, and extending from a line parallel to the wharves, and 50 feet outside of them towards the middle of the river, making the improved channel about 300 feet wide.

Owing to lack of funds work was stopped August 27, 1889.

On this project an aggregate of $9,798.74 had been expended up to June 30, 1890, and a total of 46,239 cubic yards of material removed. The expenditure of this appropriation has afforded very marked relief, and the work should be continued until a uniform depth of 16 feet is obtained over the whole extent of the bar.

July 1, 1889, amount available, but covered by existing contracts	$5,586.98
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	5,385.72
July 1, 1890, balance available	201.26
Amount appropriated by act of September 19, 1890	10,000.00
Amount available for fiscal year ending June 30, 1891	10,201.26

(See Appendix LL 10.)

11. *St. Clair Flats Canal, Michigan.*—Before the construction of this canal the St. Clair River emptied into Lake St. Clair through seven principal mouths or passes, the one ordinarily used by vessels being known as the South Channel, and having a minimum depth of a little less than 11 feet.

The St. Clair Flats Canal was projected in 1866 with a view to obtaining a straight channel 13 feet deep and 300 feet wide across the flats east of the mouth of the South Channel, and the work was finished in 1871.

The canal is bounded on each side by a dike 7,221 feet long, or an aggregate of 14,442 feet, these dikes consisting of timber resting upon piles driven into the original bottom of the shoal, the crib-pockets being filled with material dredged from the channel, and the cribs backed with dredged material.

To maintain a channel-bank a single row of sheet-piling was driven along the channel-face of the cribs previous to dredging, and the back or lake sides of the dikes were protected from wave action by shorter sheet-piling.

In 1873 the channel was deepened to 16 feet by dredging for a width of 100 feet on each side of the axis of the canal, or a width of 200 feet in all, being thus limited by the fact that the sheet-piles, intended for a depth of 13 feet, have not sufficient penetration to admit of dredging to 16 feet for the full width of 300 feet.

Moreover, the single row of sheet-piling is insufficient to prevent leakage of the dike filling through it into the channel, and it is necessary to re-inforce it with a double row, giving the latter, however, sufficient penetration to admit of subsequent dredging to a depth of 20 feet.

The entire timber structure is much decayed above water, and this portion should be renewed as soon as possible. Its condition has been duly reported in the Annual Reports for a number of years past, and there is nothing now to add except that its condition becomes worse with each succeeding year. It has now been in place an average of twenty-two years.

The approved general project for remedial measures contemplates driving a double row of sheet-piling to a depth of 26 feet along the channel-face of each dike, dredging the area between the dikes to a depth of 20 feet, continuing the channel above and below the canal to the same depth in river and lake, and rebuilding the decayed portions of the timber superstructure, at an estimated cost of $200,000, exclusive of the cost of dredging.

Under the appropriation of $75,000 made by the river and harbor act of August 11, 1888, the sum of $70,000 was set aside for continuing the construction of the sheet piling.

The sum of $655,124.01 has been expended on this improvement up to June 30, 1889, $52,071.61 of which has been expended on the present project, and at that time 6,531 linear feet of the new sheet-piling had been finished. During the year ending June 30, 1890, $36,537.90 was expended and 4,385 linear feet of sheet-piling finished, about 3,600 linear feet still remaining to be done.

It is proposed to continue the sheet-piling to completion as rapidly as possible, and if the funds made available are sufficient to warrant it, to begin dredging the channel to the depth of 18 feet and full width of 300 feet at the same time work is resumed on the sheet-piling.

When it is considered that a commerce of over 20,000,000 tons per annum is dependent upon this channel, the importance of completing its improvement at the earliest possible date can readily be understood.

July 1, 1889, amount available but covered by existing contracts	$36,678.39
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	36,537.90
July 1, 1890, balance available	140.49
Amount appropriated by act of September 19, 1890	80,000.00
Amount available for fiscal year ending June 30, 1891	80,140.49

Amount (estimated) required for completion of existing project	$196,250.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix L L 11.)

12. *Operating and care of St. Clair Flats Canal, Michigan.*—The canal is in immediate charge of a custodian, who, without additional compensation, also acts as inspector whenever any work is in progress.

During the fiscal year ending June 30, 1890, the ordinary current expenses of operating and care of the canal, such as salary of custodian, trimming willows, etc., amounted to $2,145.16.

The estimated cost of operating and care of the canal for the fiscal year ending June 30, 1891, is as follows:

Salary of custodian	$1,500.00
Current repairs and contingencies which can neither be foreseen nor estimated for in detail, to include a fair proportion of the expenses of the office of the superintending engineer at Detroit	3,500.00
Total	5,000.00

All of which is provided for by indefinite appropriation (section 4 of the river and harbor act of June 5, 1884).

The aggregate amount expended on operating and care of this canal to June 30, 1889, was	$55,074.94
The amount expended during the fiscal year ending June 30, 1890, was	2,145.16
The total expenditure to June 30, 1890, was	57,220.10

(See Appendix L L 12.)

13. *Grosse Pointe Channel, Michigan.*—The difficulty attending navigation over the flats off Grosse Pointe, at the foot of Lake St. Clair (head of Detroit River), has increased, and remedial measures are loudly demanded. The obstruction can easily be removed by dredging a channel through it, but the amount of excavation required is so great that no improvement of value can be made without a very considerable expenditure of money.

The annoyance to shipping because of the insufficient depth of water on these flats must increase in proportion to the improvement of the water route at other points, and the consequent increase in the size and carrying capacity of the vessels engaged in the commerce of the Lakes. The proposed improvement is one link in the chain projected for the amelioration of the general navigation of the Lakes, and, as the necessity is urgent, no time should be lost in beginning the dredging.

The commerce passing this obstruction is essentially the same as that which passes St. Clair Flats Canal and Detroit River, amounting to about 20,000,000 tons per year, or an average of about 90,000 tons per day for the season of navigation. The estimated cost of the improvement, based upon a channel depth of 19½ feet, is $553,300.

This depth will suffice for several years, and the cost of removing the additional half foot to attain the depth of 20 feet, recognized as that which it is desirable the channel should ultimately have in common with the entire route, would be out of proportion to the immediate benefit.

By the river and harbor act of August 11, 1888, the sum of $75,000 was appropriated for "improving St. Clair Flats Ship Canal, * * * all or any portion of which may, in the discretion of the engineer, be expended in dredging Grosse Pointe Channel."

For the reasons stated in the Annual Report of the Chief of Engineers for 1889, pages 2268, *et seq.*, $5,000 was reserved from this appropriation for the removal of any small and *well-defined* obstruction that might

be found at Grosse Pointe, as well as for the purpose of making such surveys as might be necessary before making a definite project, and no occasion for expenditure arose during the year ending June 30, 1889.

On July 2, 1889, however, a shoal was discovered in the prescribed channel with 14 feet least depth of water on it. This shoal was removed on July 11 and 12, at a cost of $290, by a dredge hired by the hour. No other occasion for dredging has arisen during the year ending June 30, 1890.

During the winter months everything was gotten in readiness for a survey of the channel as soon as the ice should form, all the shore-work being completed, but the winter proving an open one, no ice survey could be made, and a report was submitted, based on available data, sufficient examination having been made to show that no error of any consequence was involved in the use of the lake survey data for making the estimates of quantities of material to be removed to obtain the desired width and depth of channel. These estimates are as follows:

For a channel 800 feet wide and 20 feet deep, $690,800.

For a channel 800 feet wide and 19½ feet deep, $553,300.

To accomplish valuable results a large appropriation will be required at first. Unless this be granted the results will be unsatisfactory, and the eventual cost will be greatly increased. With an available sum of $200,000 a narrow channel of the proposed depth can be opened, and will afford immediate though insufficient relief. Its width can subsequently be increased to such an extent as may be necessary.

Amount expended during fiscal year ending June 30, 1890, $1,155.95

July 1, 1889, amount available	$5,000.00
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,155.95
July 1, 1890, balance available	3,844.05
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	553,000.00

(See Appendix L L 13.)

14. *Clinton River, Michigan.*—In 1870 the channel over the bar at the entrance to this river afforded a depth of only 3½ feet, whilst the depth in the river for some distance above was 10 feet.

A project for dredging a channel across the bar was approved and carried into effect in 1870. A project for the general improvement of the river from its mouth to the city of Mount Clemens was submitted in 1880, renewed in June, 1889, and approved by the Chief of Engineers under date of June 14, 1889. It contemplates a navigable depth of 8 feet for the entire distance, and involves closing a high-water channel and dredging a shoal at the lower end of Mount Clemens; opening a straight channel across "Shoemaker's Bend;" closing "Catfish" (or Blind) channel, and a construction of a revetment on the north side of the channel from the visible bank at the mouth to the requisite depth of water in Lake St. Clair, together with such dredging as may subsequently be found necessary to attain the desired navigable depth, the estimated cost of the improvement being $32,926.

The river and harbor act of August 5, 1886, appropriated $6,000 for the work, and $1,584.19 of this was expended in dredging certain shoals in the river to afford temporary relief. For the reasons stated in the report of the Chief of Engineers for 1888, page 1973, this expenditure is not fairly chargeable to the general project.

The river and harbor act of August 11, 1888, appropriated $10,000 for the work, so that at the beginning of the present fiscal year $14,361.86 was available for the improvement.

With this fund it was proposed to close the high-water channel and remove the shoal at Mount Clemens and to make the cut across "Shoemaker's Bend." Should any balance remain it was to be applied to closing Cat-fish Channel, and to such other work in the vicinity of the mouth of the river as it would suffice to accomplish.

In accordance with this project, after due advertisement bids for the work were opened, and on September 10, 1889, a contract was entered into with Messrs. Hubbell & Skeldon.

During the fiscal year the contractors made the cut across "Shoemaker's Bend," and built a revetment across the head of the old channel; closed the high-water channel and removed the shoal at Mount Clemens; made two dredge cuts, each 26 feet wide, at the mouth of the river; removed the shoal at Moore's Bend, and began dredging at Green Fence Bend. They have excavated a total of 31,569 cubic yards, bank measure, and 8,189 cubic yards scow measure.

The estimated cost of the approved project is $32,926.—The amount that was available for the work now in progress was $14,361.86. The work to be done in revetting the north side of the channel at the mouth is of such a character that it can only be advantageously done when the funds applicable thereto are sufficient to carry it to completion without interruption.

The aggregate expended on this improvement to June 30, 1889, was		$27,138.14
The amount expended during the fiscal year ending June 30, 1890, was		11,769.81
Total expenditures to June 30, 1890		38,907.95
July 1, 1889, amount available		14,361.86
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$9,100.33	
July 1, 1890, outstanding liabilities	2,669.48	
July 1, 1890, amount covered by uncompleted contracts made during the fiscal year ending June 30, 1890	2,592.05	
		14,361.86
Amount appropriated by act of September 19, 1890		10,000.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		8,564.14

(See Appendix L L 14.)

15. *Detroit River, Michigan.*—Originally the channel at Lime Kiln Crossing, Detroit River, could not be depended upon for more than 13 feet of water, the ordinary depths being much affected by the direction of the wind. As originally projected in 1874, the improvement at this point was to consist of a curved channel 300 feet wide, with a uniform depth of 20 feet, and the original estimate was based upon this project.

In 1883 it was wisely determined to so modify the project as to secure a straight channel, the least width of which should be 300 feet, with a somewhat greater width at each end, utilizing the work already done.

In 1886 this was further modified to the end that the width of the channel should be increased to 400 feet by removing an additional 100 feet from the western (American) side.

The appropriation of $37,500 made by the river and harbor act of August 5, 1886, was applied towards this project, resulting in the comple-

tion of the 300-foot channel, and the removal of an additional cut 50 feet wide for nearly the whole extent of the improvement.

By the river and harbor act of August 11, 1888, the sum of $130,500 was appropriated to complete this improvement. When tenders were called for, it was found that the lowest bid was at such a price as would not only suffice to complete the 400-foot channel, but an additional width of 40 feet, and upon presentation of the facts to the Chief of Engineers the project was again modified, the authority being dated November 19, 1888.

Under the contract with Messrs. Dunbar & Sullivan, dated October 30, 1888, work at Lime Kiln Crossing has been continued during the fiscal year, and the following results have been obtained at the work:

When done.	Excavation in cubic yards.	
	Solid rock.	Loose rock.
During fiscal year ending June 30, 1890	*16,583	*1,766
Under present contract	*25,091	*1,796
Since beginning improvement	*103,497 †2,632	*2,843

* Bank measure.
† Scow measure, additional.

Upon application of the contractors the contract of Messrs. Dunbar & Sullivan was extended from June 30, 1890, to October 31, 1890. It is fully expected, however, that the work will be completely finished before the latter date.

The extent to which this improvement is used is shown by the fact that during the calendar year 1889, 32,415 American vessels, having 19,646,000 tons register, passed through the Detroit River. If records of the Canadian vessels could be obtained a still larger showing would be made.

The aggregate expended on this improvement to June 30, 1889, was	$612,807.22
The amount expended during the fiscal year ending June 30, 1890, was	79,292.26
Total expenditure to June 30, 1890	692,099.48

The funds now available being sufficient to complete the work, no estimate is submitted for further appropriations.

July 1, 1889, amount available, but covered by existing contracts		$90,303.19
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$62,433.44	
July 1, 1890, outstanding liabilities	16,858.82	
July 1, 1890, amount covered by uncompleted contracts June 30, 1890	11,010.93	
		90,303.19

(See Appendix L L 15.)

16. *Rouge River, Michigan.*—Before improvements were begun, Rouge River had a channel of 11 feet over the bar at its mouth, and from 10 to 17 feet thence to the bridge of the St. Louis and Wabash Railroad, a distance of nearly 15,000 feet. In earlier days vessels had ascended it to Dearborn, a distance of about 15 miles.

The approved project for improvement contemplates dredging the river to a depth of 16 feet and width of 240 feet at the mouth, gradually narrowing to 100 feet at a distance of about 1,150 feet above, and then continuing this width to the bridge of the St. Louis and Wabash Railroad, a total distance of about 15,000 feet.

The river and harbor act of August 11, 1888, appropriated $10,000 for this work, and of this $9,875 was expended up to June 30, 1889, resulting in the removal of 81,163 cubic yards of material and giving a channel 16 feet deep, 240 feet wide at the mouth, and gradually narrowing to 100 feet at a distance of about 1,150 feet above, and 60 feet in width at bottom, thence for an additional distance of about 7,600 feet, or a total of 8,750 feet.

In view of the degree of relief afforded, and the comparatively small cost of the work, the result was very satisfactory.

Nothing has been expended during the year ending June 30, 1890.

July 1, 1889, amount available	$125.00
July 1, 1890, balance available	125.00
Amount appropriated by act of September 19, 1890	10,000.00
Amount available for fiscal year ending June 30, 1891	10,125.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	11,690.39

(See Appendix L L 16.)

EXAMINATION AND SURVEY FOR IMPROVEMENT, TO COMPLY WITH REQUIREMENTS OF RIVER AND HARBOR ACT OF AUGUST 11, 1888.

It appearing from the preliminary examination made by the local engineer of *Detroit River, at Grosse Pointe, Michigan, to dredge channel now in use to depth of 20 feet*, that the locality is worthy of improvement, and the public necessity therefore being apparent from the facts and reasons reported; which are concurred in by the Chief of Engineers, Colonel Poe was charged with and completed its survey, the results of which were transmitted to Congress and printed as House Ex. Doc. No. 200, Fifty-first Congress, first session. (See also Appendix L L 17.)

IMPROVEMENT OF HARBORS ON LAKE ERIE, WEST OF ERIE, PENNSYLVANIA—IMPROVEMENT OF SANDUSKY RIVER.

Officer in charge, Maj. L. Cooper Overman, Corps of Engineers; Division Engineer, Col. H. L. Abbot, Corps of Engineers.

1. *Monroe Harbor, Michigan.*—The original project for the improvement of this harbor was adopted in 1835, when Monroe was a town of considerable importance, and when the navigable waters of the River Raisin were separated from the waters of Lake Erie by extensive shoals. It provided for cutting a canal through River Raisin Point between the river and the lake, 4,000 feet long and 100 feet wide, and protecting the entrance into the lake by parallel piers, the object being to afford a channel of entrance of navigable width, with a depth of 10 feet. Work was commenced in 1835 and has been continued from time to time since that date.

At the close of the last fiscal year there was a fair channel with a least depth of 9 feet, up to a point below Monroe where rock bottom exists, which is deemed sufficient for the present commerce of the port.

During the fiscal year ending June 30, 1890, the balance of appropriation of 1889, amounting to $130.03, was expended in pressing repairs. No other work was done during the fiscal year for want of funds.

July 1, 1889, amount available	$130.03
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	130.03
Amount appropriated by act of September 19, 1890	5,000.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	15,000.00

(See Appendix M M 1.)

2. *Toledo Harbor, Ohio.*—The original project provided for making the existing channel 200 feet wide and 12 feet deep through Maumee Bay, and this was amended from time to time, resulting in the present project, which provides for a width of 200 feet at bottom and a depth of 16 feet at low water between the city of Toledo and deep water in Lake Erie.

The total amount appropriated for this harbor for the several projects for improving the *natural* channel, from 1866 to close of fiscal year ending June 30, 1890, is $719,046.71, all of which has been expended, and has resulted in obtaining a 15½ foot channel where before there was a narrow intricate channel with but 11 feet depth.

The estimated cost of the present project for natural channel was $570,000, which will not complete the project as originally estimated, owing to the time consumed in doing the work for want of adequate appropriation; the annual removal of deposits of each winter and spring, repeated for thirteen years, and other necessary expenses, having absorbed at least $100,000 of the original estimate. It will therefore require at least $150,000 to complete the deepening and widening of the natural channel between Toledo and 16 feet of water in Lake Erie, after which an annual expenditure of about $20,000 will be needed to maintain the dredged channel through the open bay, or until the straight channel improvement is completed.

The act of August 11, 1888, appropriated for continuing the improvement of Maumee River by a *straight* channel $150,000; and for clearing the "old channel" $5,000, for improving harbor at Toledo, Ohio.

A project for the expenditure of the appropriation of 1888, in accordance with the report of The Board of Engineers, was adopted, and a contract was made for dredging about 660,000 cubic yards along the proposed straight channel.

Great difficulty was had in obtaining satisfactory bids for the dredging required, owing to the existence of a combination among dredge men on Lake Erie to secure high prices for the work.

Work has been carried on under this contract during working months of the fiscal year 1890. Six hundred and fifty-nine thousand nine hundred and seventy cubic yards of material were excavated and removed, the excavation being completed June 6, 1890.

The amount of work done on the straight channel, as compared with the entire project, can not be of full practical benefit to navigation until completed, nor can any comparisons yet be made as to benefits to be be derived.

Straight channel.

July 1, 1889, amount available		$10,690.38
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$10,215.67	
July 1, 1890, outstanding liabilities	474.71	
		10,690.38

Amount appropriated by act of September 19, 1890		$200,000.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		1,412,500.00
Old channel.		
July 1, 1889, amount available		$4,969.65
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$4,839.34	
July 1, 1890, outstanding liabilities	130.31	
		4,969.65
Amount appropriated by act of September 19, 1890		5,000.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		40,000.00

(See Appendix M M 2.)

3. *Port Clinton Harbor, Ohio.*—In 1870 the channel at the entrance to this harbor was narrow and intricate, with a depth of only 5 feet.

The present project, adopted in 1875, provides for a pile revetment from the north side of the Portage River opposite the town 967 feet into the lake, and two pile-piers, 200 feet apart, of an aggregate length of 4,100 feet, extending to the depth of 10 feet in the lake, with a view to maintaining a depth of 9 feet between them.

The act of August 11, 1888, appropriated $5,000 for continuing improvement, and at the close of the fiscal year 1889 all had been expended in making the most urgent of the repairs and in dredging. Nothing was done during the fiscal year ending June 30, 1890, for want of funds. Considerable repairs are still required, and dredging also is greatly needed.

The total amount appropriated for this harbor to the close of the fiscal year ending June 30, 1890, has been $53,000, all of which has been expended, and has resulted in obtaining a depth of 8 feet from the lake to the town. The proposed improvement is only about one-half finished.

July 1, 1889, amount available	$200.57
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	200.57
Amount appropriated by act of September 19, 1890	3,000.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	34,000.00

(See Appendix M M 3.)

4. *Sandusky City Harbor, Ohio.*—The original depth in the channel through the outer bar was 10 feet and greatest depth in bay about 12 feet.

The project adopted in 1880 provides for a channel through the outer bar and through the bay 200 feet wide, and parallel to the city docks 100 feet wide, the whole to be 15 deep.

An increased depth of 17 feet at low water in the channel is recommended for this harbor by the officer in charge on account of the increased size of vessels navigating the lakes. The estimated cost of this extra depth is $61,000.

A project for a "straight channel" for this harbor, extending from the east end of the dock channel to the north end of Cedar Point, has received the sanction of Congress, and the act of August 11, 1888, appropriated $35,000, more or less, with which to begin this improvement, all of which was expended in dredging along the line of "straight chan-

nel." This new channel when completed will materially shorten and improve the existing entrance. The estimated cost is $96,712, an increase of only $46,712 over the estimate for the project of 1880 as revised to give 16 feet depth.

An annual removal of at least 10,000 cubic yards is necessary to maintain the unfinished old channel, after which the additional dredging where funds permit can be applied toward the completion of the channel to 200 feet in width and 15 feet in depth, or until new channel is available.

For the expenditure of the appropriation of August 11, 1888, for straight channel, a contract was made with Christopher H. Starke, of Milwaukee, Wis., at 17 cents per cubic yard. Work was commenced May 1, 1889, and was completed October 18, 1889. All available funds for the straight channel improvement were exhausted by end of October, 1889.

At the close of the fiscal year ending June 30, 1890, the sum of $274,518.73 had been expended on old channel for this harbor, resulting in a channel through the outer bar about 150 feet wide, having a depth of about 15 feet, in which for a width of 50 feet there was a depth of 16½ feet and through the bay up to a point 50 feet from the line of docks a width of 150 feet and depth of about 14½ feet.

July 1, 1889, amount available	$3,369.93
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	3,369.93
Amount appropriated by act of September 19, 1890	45,000.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	21,712.00

(See Appendix M M 4.)

5. *Sandusky River, Ohio.*—During the years 1867 and 1872 the sum of $30,000 was expended in opening a navigable channel with a depth of 8 feet from Sandusky Bay to Fremont, a distance of 17 miles. Since 1872 the cuts then made through the various bars filled up.

The present project, which was based on a survey made in compliance with the river and harbor act of 1880, provides for opening a channel 100 feet wide and 9 feet deep between the town of Fremont, and the depth of 9 feet in Sandusky Bay, at an estimated cost of $44,000.

At the close of the fiscal year ending June 30, 1883, the sum of $21,500 had been appropriated for the present project, of which the sum of $20,871.53 has been expended. There was at the close of the season of 1889 a fair channel, with least depth of 8 feet, from Fremont, the head of navigation, to the lake.

The balance on hand at beginning of the fiscal year, viz, $628.47, was expended in May and June, 1890, in some necessary dredging. Some complaints during the past year have been made of the shoaling of the old cuts, and additional dredging is deemed necessary.

July 1, 1889, amount available		$628.47
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$189.00	
July 1, 1890, outstanding liabilities	439.47	
		628.47
Amount appropriated by act of September 19, 1890		1,500.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		21,000.00

(See Appendix M M 5.)

6. *Huron Harbor, Ohio.*—The project for the improvement of this harbor was adopted in 1826, when the mouth of the river was closed by a sand-bar. This project has been amended from time to time as the demands of commerce called for an increased depth of channel, and now consists of parallel piers 140 feet apart, extending to the depth of 14 feet in the lake.

At the close of the fiscal year ending June 30, 1890, there was a good channel through the outer bar with a depth of 15½ feet, and between the piers with a depth of from 16 to 17 feet. The superstructure of both piers, except where repaired in 1884, 1886, and 1888, was in a decayed condition and needed immediate renewal.

The heavy gales of the springs of 1887, 1888, and 1889, did considerable damage to the piers and to the beaches, so that a breach was probable at the inner end of east pier near the shore.

Urgent repairs were made during the year, but considerable repairs are still needed. Dredging is also needed.

Up to the end of the fiscal year 1890 the sum of $123,273.71 had been appropriated for this harbor, all of which has been expended. A good channel with least depth of 14 feet was maintained until piers became dilapidated, where originally there was a sand-bar dry at low water. During the fiscal year ending June 30, 1890, no work was done for want of funds.

The estimated cost of renewing the superstructure of the piers is $22,000. Repairs in addition to those completed when the estimate was submitted have been made necessary by the storms of 1888 and 1889, and the amount asked for to completely renew the piers has been correspondingly increased.

July 1, 1889, amount available	$61.95
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	61.95
Amount appropriated by act of September 19, 1890	16,000.00

(See Appendix M M 6.)

7. *Vermillion Harbor, Ohio.*—Before improvement, the mouth of the Vermillion River was closed by a sand-bar, upon which there was a depth of less than 2 feet. The original project consisted of parallel piers running out into the lake from each side of the mouth of the river, in order to secure a depth of 10 feet. This project has been amended from time to time, and now provides for a depth of 14 feet.

In 1878 the channel was about 70 feet wide, with a depth of about 12 feet, and has since remained nearly permanent.

The act of August 11, 1888, made an appropriation of $1,000 for this harbor. Only partial repairs to the piers could be made with the sum available, which repairs were made during the spring of 1890.

At the close of the fiscal year ending June 30, 1890, the piers were in only fair condition; the depth in the channel was about the same as at close of the previous fiscal year, viz, 10¾ feet. The amount appropriated to close of fiscal year 1890 has been $118,942.32, all of which has been expended.

July 1, 1889, amount available	$1,000.00
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,000.00
Amount appropriated by act of September 19, 1890	2,000.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	8,000.00

(See *Appendix M M 7.*)

8. *Black River Harbor, Ohio.*—The original project for the improvement of this harbor was adopted in 1828, and amended from time to time as the demands of commerce called for an increased depth of channel. The present project provides for parallel piers 200 feet apart, running out to a depth of 16 feet in the lake.

Up to the close of the fiscal year ending June 30, 1890, and since 1826, there had been appropriated the sum of $220,138.73, all of which has been expended, and with which a channel with least depth of 16 feet has been obtained where originally there was but 3 feet at the entrance.

The act of August 11, 1888, appropriated $10,000 for this harbor. The extension of pier and repairs to piers under contract were begun in April, 1889, and were completed by the end of June, 1889, and appropriation nearly exhausted. The piers need considerable renewal of superstructure.

During the month of October, 1889, some dredging was needed and the entire balance of funds, viz, $369.85, was expended in the excavation of 1,057 cubic yards of material. The Cleveland, Lake Erie and Wheeling Railway Company did some additional dredging at their own expense. The total amount of material removed was about 2,000 cubic yards, which placed the channel in good condition.

Only one-third of the proposed extension of the piers has been accomplished. This is the most important work, and should be completed as soon as funds sufficient are available.

The unexpected and extra repairs made and to be made at this harbor will increase the estimate for same, and the renewal and prolonging of the piers will cost at least $12,000.

July 1, 1889, amount available	$761.53
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	.761.53
Amount appropriated by act of September 19, 1890	12,000.00

(See Appendix M M 8.)

9. *Cleveland Harbor, Ohio.*—The original project for the improvement of the mouth of Cuyahoga River was adopted in 1825, and has been amended from time to time to gain increased depth. It consists of parallel piers about 200 feet apart running out to a depth of 16 feet in the lake.

When operations were commenced there was a long, low sand-bar where the river now empties into the lake, and the entrance was through a narrow, intricate channel with a depth of about 3 feet.

At the close of the fiscal year ending June 30, 1890, there had been expended about $375,000, and there was as a result a good, wide channel at the entrance of the harbor, with a depth of from 14 to 16 feet between the railroad bridge at the inner end of the piers and the lake, with a pile protection work 620 feet long at the inner end of the west pier, constructed in 1882.

Harbor of refuge.—The original project provided for an outer breakwater starting from the lake shore about 700 feet west of the upper end of the old river-bed.

The west breakwater runs out about due north a distance of 3,130 feet to a depth of 28 feet, and thence for 4,030 feet it runs nearly parallel to the shore, with a spur 100 feet long on the north side of the lake arm, 200 feet from its eastern end, in a depth of from 28 to 30 feet. It was originally proposed to protect the entrance to the harbor on the east side by extending the east pier at the mouth of the river 1,400 feet.

Amended projects changed this plan, and now provide for a breakwater on the east side, which begins at a point on the prolongation of the arm of the west breakwater, and 500 feet from it, extends eastward on the line about 3,500 feet, then inclines towards the shore in a depth of 26 feet of water, and extends 2,000 feet, having an entrance 2,300 feet wide between the eastern end and the curve of 14 feet depth of water, or about 2,200 feet from shore.

By the expenditure of the appropriation of August 11, 1888, the construction of about 550 linear feet of the east breakwater was made. Operations were commenced in March, 1888, and were continued, when weather permitted, until end of October, 1889.

The amount expended during the fiscal year was $59,492.70.

At the close of the fiscal year 1890 a total of about $1,000,585.50 had been expended and 8,860 linear feet of breakwater had been finished, which completes the west breakwater and over 1,700 linear feet of the east breakwater, leaving to be built to complete the harbor of refuge about 3,800 linear feet of east breakwater.

The total amount appropriated for the harbor of refuge to July 1, 1889, is $1,093,750, of which sum $1,093,578.20 has been expended therefor, less about $42,000, which has been applied to repairs to piers, dredging, etc., for Cleveland Harbor proper in a period of fifteen years.

July 1, 1889, amount available	$2,402.88
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	2,231.08
July 1, 1890, balance available	171.80
Amount appropriated by act of September 19, 1890	75,000.00
Amount available for fiscal year ending June 30, 1891	75,171.80
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	444,250.00

(See Appendix M M 9.)

10. *Fairport Harbor, Ohio.*—The present project for the improvement of this harbor consists of parallel piers, 200 feet apart, running into the lake. It was adopted in 1825, and has been modified by prolonging the piers from time to time, so as to give increased depth, the object now being to afford a channel of navigable width and not less than 16 feet in depth.

When the work was commenced in 1826 the mouth of the river was closed by a sand-bar 1,200 feet wide, at times so hard and dry that teams could cross over it.

At the close of the fiscal year ending June 30, 1890, there was a fair channel between the piers with a least depth of 15½ feet at low water, and in lake beyond end of piers with a least depth of 15½ feet at ordinary level of the lake, but not for full width needed.

During the fiscal year ending June 30, 1890, contracts were in progress and work completed for necessary repairs to piers and for extension of the west pier 80 linear feet. Three agreements were made during the year for small amounts of dredging in the channel beyond end of piers. Under these three agreements the channel was kept in only fair condition, and additional dredging is much needed.

Extensive improvements as to docks and yards for receiving cargoes of iron ore and shipping coal have been made at Fairport Harbor by Pittsburgh capitalists. These improvements were continued during the fall of 1889, and it is *expected that* they will be further extended

this season and the business of this harbor still further increased thereby. This increased commerce demands increased channel depth, and as a consequence additional extension of piers.

July 1, 1889, amount available	$1,140.65
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,140.65
Amount appropriated by act of September 19, 1890	30,000.00

(See Appendix M M 10.)

11. *Ashtabula Harbor, Ohio.*—The original project for the improvement of this harbor was adopted in 1826. Rock bottom was then found at 9 feet below the surface, and there was a depth of only 2 feet of water over bar at the entrance to harbor.

The present project contemplates the extension of the piers out to 16 feet depth of water, the removal of the decayed portions of both piers and rebuilding with new material; also rock excavation and dredging to give channel of 160 feet width and full depth.

During the fiscal year 1890 the condition of the channel was improved by the removal of about 3,700 cubic yards of loose rock and soft material and 3,300 cubic yards of ledge rock by contracts.

At the close of the fiscal year ending June 30, 1889, there was a good wide channel 15½ to 16 feet deep from the lake into the harbor.

A contract was completed during the fiscal year for the excavation of rock from bar in lake and from channel between the piers to the extent of available funds.

The excavation was commenced in May, 1889, and all the work required under the contract completed by November 30, 1889.

In November, 1889, a small amount of dredging was done from bar in lake beyond end of piers under an agreement made with M. A. Hanna & Co., of Cleveland, Ohio; about 1,500 cubic yards were removed, which was sufficient to relieve immediate wants of the harbor. In the spring of 1890 further dredging was found necessary, and an agreement was made with G. H. Kimball, of Cleveland, Ohio, for dredging from bar to extent of available funds; about 2,500 cubic yards were removed during April and May under this contract at a cost of $450.

The channel through the outer bar is being excavated to 18 feet depth and full width. The channel between the piers is being excavated to 17 feet depth and of such width as the available funds will permit, viz, 80 feet, all in rock bottom. A contract was also made with B. S. Horton for the extension of the east pier 120 feet and repairs to piers, which work was completed November 30, 1889.

There was appropriated for this harbor up to the close of the fiscal year ending June 30, 1890, $427,401.21, all of which has been expended.

July 1, 1889, amount available	$1,179.24
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,103.52
July 1, 1890, balance available	75.72
Amount appropriated by act of September 19, 1890	40,000.00
Amount available for fiscal year ending June 30, 1891	40,075.72

(See Appendix M M 11.)

12. *Removing sunken vessels or craft obstructing or endangering navigation—Removing wreck of schooner Joy.*—In November, 1887, schooner *Joy*, with cargo of iron ore, was sunk near channel about 350 feet from lake end of east pier at Ashtabula Harbor, Ohio. Bids twice invited

for its removal during 1888 were rejected, being too high and in excess of amount allotted for the work.

Proposals were again invited in September, 1889, and offer received from Messrs. Carkin, Stickney & Cram, of East Saginaw, Mich., to do the work for the sum of $2,475, which offer was accepted. Work was commenced in October, 1889, and removal of wreck and cargo and accumulated sand, etc., at and near site of wreck to a depth of 16½ feet was completed November 28, 1889; the total cost of removal being $2,550.

(See Appendix M M 12.)

IMPROVEMENT OF ERIE HARBOR, PENNSYLVANIA, AND DUNKIRK, BUFFALO, WILSON, OLCOTT, AND OAK ORCHARD HARBORS, AND TONAWANDA HARBOR AND NIAGARA RIVER, NEW YORK.

Officer in charge, Maj. Amos Stickney, Corps of Engineers, since April 24, 1890; Division Engineer, Col. H. L. Abbot, Corps of Engineers. These works were in charge of Capt. Frederick A. Mahan, Corps of Engineers, until April 24, 1890.

1. *Erie Harbor, Pennsylvania.*—The original survey of this harbor was made in 1819, at which time the channel was narrow and tortuous, with a depth of only 6 feet. In 1823 a plan for the improvement was adopted, and constitutes the present work at the entrance to the harbor, excepting some changes which have been required either on account of the age of the structures already built or other causes.

The piers have been extended from time to time and are now in fair condition.

The present project contemplated the extension of the piers to the 16-foot curve in the lake, and the maintenance of a channel of navigable width and 16 feet in depth from the harbor inside to the lake outside.

Operations have been prosecuted with more or less interruption and suspension (no work was done from 1838 to 1842, from 1846 to 1853, and from 1855 to 1864), and have resulted in much benefit to the harbor and its channel entrance.

The work during the year consisted of repairs to the breakwater and north pier; dredging in channel; and survey of the peninsula and bay. Dredging was in progress at the end of the year, which, when finished, will put the channel in good condition.

The total amount expended up to June 30, 1889, not including outstanding liabilities, was $707,809.83. The amount expended during fiscal year ending June 30, 1890, was $26,783.36. These expenditures resulted in the construction and maintenance of the north and south piers, north and south breakwaters, and dredging in channel.

July 1, 1889, amount available		$62,376.51
Add amount covered by contracts July 1, 1889		16,180.25
		78,556.76
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$21,282.72	
July 1, 1890, outstanding liabilities	2,152.97	
July 1, 1890, amount covered by uncompleted contracts made during the fiscal year ending June 30, 1890	25,778.81	
		49,214.50
July 1, 1890, balance available		29,342.26
Amount appropriated by act of September 19, 1890		40,000.00
Amount available for fiscal year ending June 30, 1891		69,342.26

Amount (estimated) required for completion of existing project ..... Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	$47,657.74

(See Appendix N N 1.)

2. *Preservation and protection of the peninsula at Presque Isle, Erie Harbor, Pennsylvania.*—In a report upon the examination of Erie Harbor, made in 1885, it was recommended that the neck of the peninsula be protected by a breakwater, and that the movement of sand around the eastern end of the peninsula, which threatens to close the harbor entrance, be arrested by the construction of jetties perpendicular to the shore of the peninsula, at an estimated cost of $173,044.50.

Work under this project was in progress during the year until October, 1889, when the project was abandoned, it having been found that the structures built would not stand against the violence of the storms. No further work is at present contemplated, but the sum of $20,000 has been reserved from the appropriation for the improvement of Erie Harbor, to be used in case of necessity in closing any breach which might occur.

The total amount expended up to June 30, 1889, not including outstanding liabilities, was $200.25. The amount expended during fiscal year ending June 30, 1890, was $59,799.75.

Amount covered by contracts July 1, 1889	$59,649.75
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	59,649.75

(See Appendix N N 2)

3. *Dunkirk Harbor, New York.*—The improvement of this harbor was commenced in 1827, when the first appropriation therefor was made. The original project was much the same as that of the existing improvement, which comprises the formation of an artificial harbor in front of the city by means of a breakwater running nearly parallel with the shore, and a shore-arm or pier to the westward, with an opening between the pier and breakwater. By 1832 the sum of $28,489.84 had been expended on the original plan, and the breakwater was then 2,564 feet long and the pier 1,400 feet long.

Various improvements and repairs were made from time to time, and by 1838 there had been completed 2,125 feet of breakwater and 300 feet of detached breakwater. In 1848 the breakwater was demolished.

Between 1848 and 1870 some portions of the work were renewed and others repaired, but in 1870 a Board of Engineers took into consideration the question of the radical improvement of the harbor. The Board recommended a plan which provided a breakwater 2,860 feet long, one part of which, 2,300 feet in length, was to be nearly parallel with the shore, the other part to be nearly parallel to the axis of the channel entrance, 500 feet long, and terminating at the position of the dumb beacon, and the formation of a channel 170 feet wide and 13 feet deep; of the 2,300-foot section 1,343 feet have been completed; none of the 560-foot section has been built.

Work during the year consisted in repairs of the west pier and dredging in the channel. The superstructures of the breakwaters and the pier are in very bad condition and need rebuilding. The channel is now 100 feet wide, 13 feet deep, and requires considerable dredging and rock excavation to make it 170 feet wide as proposed.

The total amount expended up to June 30, 1889, not including outstanding liabilities, was $479,008.15. The amount expended during the fiscal year ending June 30, 1890, was $13,613.08.

July 1, 1889, amount available		$9,396.23
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$7,938.08	
July 1, 1890, outstanding liabilities	7.36	
		7,945.44
July 1, 1890, balance available		1,450.79
Amount appropriated by act of September 19, 1890		20,000.00
Amount available for fiscal year ending June 30, 1891		21,450.79
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		147,916.41

(See Appendix N N 3.)

4. *Buffalo Harbor, New York.*—The original project for the improvement of this harbor was adopted in 1826, and, as modified at various times, provided for the construction of piers on the north and south sides of Buffalo Creek, a masonry sea-wall running south from the inshore end of the south pier, and a breakwater less than half a mile in front of the Buffalo light-house, its long arm being nearly parallel with the shore.

The present project was adopted in 1874, and provides for the construction of a breakwater of crib-work, 7,600 feet long, running parallel with the shore, and a shore-arm of piles and crib-work, 4,100 feet long running out toward the southern end of the main or detached breakwater, leaving an opening of about 150 feet between them.

In 1887 this project was amended so that in the reconstruction of superstructure concrete was substituted for timber crib work.

During the past year the principal work has been the reconstruction of a portion of the superstructure, the new work being of concrete and extending for a length of 1,471.8 feet.

The total amount expended up to June 30, 1889, not including outstanding liabilities was $2,009,818.46. The amount expended during the fiscal year ending June 30, 1890, was $148,279.06.

July 1, 1889, amount available		$100,194.97
Add amount covered by contracts, July 1, 1889		59,971.02
		160,165.99
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$126,783.10	
July 1, 1890, outstanding liabilities	9,570.88	
July 1, 1890, amount covered by uncompleted contracts made during fiscal year ending June 30, 1890	14,718.11	
		151,072.09
July 1, 1890, balance available		9,093.90
Amount appropriated by act of September 19, 1890		300,000.00
Amount available for fiscal year ending June 30, 1891		309,093.90
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		446,223.17

(See Appendix N N 4.)

5. *Tonawanda Harbor and Niagara River, New York.*—The project for this work contemplates a channel 18 feet deep and 400 feet wide from the mouth of the Niagara River at Lake Erie to the north end of Tonawanda Harbor, New York.

On November 24, 1888, bids were opened for removing rock at the mouth of the Niagara River and straightening the channel, and for dredging at the head of Strawberry Island. The contracts were awarded to Messrs Hingston & Woods, at Buffalo, N. Y., at $11.50 per cubic yard for rock excavation, and 17 cents per yard for dredging. Work was begun in the early part of May, 1889, and has resulted in opening a channel at Horse-shoe Reef 250 feet wide and 18 feet deep. At Strawberry Island dredging was more difficult than was supposed to be the case, as there is hard rock underlying the gravel and sand of which the bed of the stream was supposed to be composed.

It became necessary to close the contract for dredging and enter into a new contract for rock excavation. Work under the last contract was commenced June 1, 1890, and is now in progress, considerable rock having been blasted but none as yet removed. It will become necessary to revise the estimate for this work which will require further survey.

The total amount expended up to June 30, 1889, was $4,584,67. Amount expended during fiscal year ending June 30, 1890, $69,386.26.

July 1, 1889, amount available		$57,075.90
Add amount covered by contracts, July 1, 1889		37,762.91
		94,838.81
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$68,809.74	
July 1, 1890, outstanding liabilities	37.03	
July 1, 1890, amount covered by uncompleted contracts made during the fiscal year ending June 30, 1890	24,000.00	
		92,846.77
July 1, 1890, balance available		1,992.04
Amount appropriated by act of September 19, 1890		75,000.00
Amount available for fiscal year ending June 30, 1891		76,992.04

(See Appendix N N 5.)

6. *Wilson Harbor, New York.*—The project for the improvement of this harbor was adopted in 1873 and modified in 1877, the object being to afford a channel of navigable width and 12 feet in depth by the extension of parallel piers from the mouth of Twelve-Mile Creek to the 12-curve in Lake Ontario, with the formation of a protected channel between the piers. The mouth of the creek was originally obstructed by a bar, upon which there was a depth of about 1 foot.

Before the commencement of operations by the United States the piers had been carried about 400 feet into the lake by private enterprise.

During the year 1888 a protection 360 feet long was built to shield the shore of the lake from the action of waves in gales from the northeast, and prevent a breach being made into the harbor. A section of the west pier 150 feet long was rebuilt. At the end of the year 1889 dredging operations were closed and a channel with a least depth of 9½ feet had been obtained. The appropriation being exhausted, work had to stop, and nothing has been done during the past fiscal year. The piers need extensive repairs and considerable dredging and rock excavation is yet required. The total amount expended up to the close of June 30, 1889, not including outstanding liabilities, was $61,625.20. During the year ending June 30, 1890, $3,262.29 was expended in final payment for work done during the previous year, and some small expenses.

July 1, 1889, amount available	$284.60
Add amount covered by contracts July 1, 1889	3,090.20
	3,374.80
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	3,262.29
July 1, 1890, balance available	112.51
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	13,978.49

(See Appendix N N 6.)

7. *Olcott Harbor, New York.*—The project for the improvement of this harbor was adopted in 1866. It proposes to connect the deep water in Lake Ontario with the deep water in Eighteen-Mile Creek by the extension of two parallel piers from the mouth of the creek to the 11-foot curve in the lake, with the addition of a dredged channel between the piers. The project was modified in 1874 and in 1881 to provide for the removal of rock found to exist in the channel between the piers and for additional pier extension. The natural channel between the mouth of the creek and the lake was obstructed by a bar upon which there was a depth of about 1½ feet.

During the past year the channel has been dredged to a depth of 12 feet for a width of 100 feet. The piers need extensive repairs and considerable dredging and rock excavation in the channel are required.

The total amount expended up to June 30, 1889, not including outstanding liabilities, was $125,323.02. The amount expended during fiscal year ending June 30, 1890, was $6,790.15.

July 1, 1889, amount available		$3,251.98
Add amount covered by contracts July 1, 1889		4,425.00
		7,676.98
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$6,790.15	
July 1, 1890, outstanding liabilities	5.00	
		6,795.15
July 1, 1890, balance available		881.83
Amount appropriated by act of September 19, 1890		30,000.00
Amount available for fiscal year ending June 30, 1891		30,881.83

(See Appendix N N 7.)

8. *Oak Orchard Harbor, New York.*—The earliest project for the improvement of this harbor was adopted in 1836, the date of the first appropriation, and proposed the construction of an east and west breakwater approaching to within 200 feet of each other, and connecting at the opening with two parallel piers extending into the lake.

Subsequent modifications were extensions of the original project to provide for the removal of rock, and to adjust the harbor to the increased demand of commerce. The present project was adopted in 1881, the object being to extend the piers to the 12-foot curve in the lake, with the formation of a channel of navigable width and 12 feet deep at low water between the piers. The natural entrance into Oak Orchard Creek was narrow, with a depth of from 2 to 4 feet.

A shore protection 91 feet long was built in 1888 to the east of the east pier.

During the past year the channel has been dredged to a depth of 12 feet with a width of 100 feet. The piers need slight repairs and considerable dredging and rock excavation *in the channel* is yet required.

The total amount expended up to June 30, 1889, was $193,693.83. The amount expended during the fiscal year ending June 30, 1890, was $5,566.31.

July 1, 1889, amount available		$3,808.37
Add amount covered by contracts July 1, 1889		2,250.00
		6,058.37
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$5,318.51	
July 1, 1890, outstanding liabilities	10.68	
		5,329.19
July 1, 1890, balance available		729.18
Amount appropriated by act of September 19, 1890		5,000.00
Amount available for fiscal year ending June 30, 1891		5,729.18
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		6,095.82

(See Appendix N N 8.)

IMPROVEMENT OF HARBORS ON LAKE ONTARIO, EAST OF OAK ORCHARD, NEW YORK.

Officer in charge, Capt. Carl F. Palfrey, Corps of Engineers, until March 10, 1890, and after that date Major M. B. Adams, Corps of Engineers; Division Engineer, Col. H. L. Abbot, Corps of Engineers.

1. *Charlotte Harbor, New York.*—The original project for the improvement of this harbor, adopted in 1829, proposed to connect the deep water in Genesee River with the deep water in the lake by parallel piers about 480 feet apart.

The present project, adopted in 1881, is for the extension of the piers to the 15-foot curve in the lake, with the formation by dredging of a channel between them of a navigable width and 15 feet in depth at low water.

The natural channel over the bar was tortuous, and in calm weather would admit at ordinary stages of the lake vessels drawing 8 feet.

The total amount expended from 1828 to June 30, 1890, is $419,954.68, including outstanding liabilities; $4,905.42 in addition is covered by existing contracts.

The amount expended from the adoption of the present project in 1881 to June 30, 1890, is $101,876.28, including outstanding liabilities. The total expenditures have resulted in extending the piers to the 13-foot curve in the lake, securing a channel between the piers 200 feet in width, and of not less than 16 feet in depth at extreme low water.

During the year 98,377½ cubic yards have been dredged from the channel.

July 1, 1889, amount available		$27,106.48
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$2,954.76	
July 1, 1890, outstanding liabilities	50.00	
July 1, 1890, amount covered by uncompleted contracts made during the fiscal year ending June 30, 1890	4,905.42	
		7,910.18
July 1, 1890, balance available		19,196.30
Amount appropriated by act of September 19, 1890		25,000.00
Amount available for fiscal year ending June 30, 1891		44,196.30

Amount (estimated) required for completion of existing project..... Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	$31,400.00

(See Appendix O O 1.)

2. *Great Sodus Harbor, New York.*—The earliest project for the improvement of this harbor, adopted in 1828, proposed the construction of two breakwaters from east and west shores, approaching to within 500 feet of each other, and connecting at the opening with parallel piers extending into the lake. Subsequent modifications were extensions of the original project, to adjust it to the increased demands of commerce.

The present project was adopted in 1882, the object being to extend the piers to the 15-foot curve in the lake, and dredging a channel between the piers 15 feet deep at low water.

The natural channel would admit vessels drawing 8 feet at ordinary lake stage.

The total amount expended from 1829 to June 30, 1890, is $416,707.34, including outstanding liabilities; $3,065.88 in addition is covered by existing contracts. The amount expended from 1881 to June 30, 1890, is $68,204.01, including outstanding liabilities. The total expenditure has resulted in the extension of the west pier to the 14-foot curve in the lake and of the east to the 9-foot, with a channel of navigable width and 15 feet deep at low water, between them.

The operations of the past year have been renewal of superstructure and dredging.

July 1, 1889, amount available.....		$12,312.73
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889.....	$1,373.19	
July 1, 1890, amount covered by uncompleted contracts made during the fiscal year ending June 30, 1890.....	3,065.88	
		4,439.07
July 1, 1890, balance available.....		7,873.66
Amount appropriated by act of September 19, 1890.....		10,000.00
Amount available for fiscal year ending June 30, 1891.....		17,873.66
Amount (estimated) required for completion of existing project..... Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		36,126.44

(See Appendix O O 2.)

3. *Little Sodus Harbor, New York.*—The earliest project for the improvement of this harbor was adopted in 1829, and has since been variously modified. The first appropriation was made in 1852. The early project proposed the partial closing of the opening between the bay and lake by lateral dikes connected with two parallel piers extending into the lake.

The present project, which is an expansion of the earlier ones, was adopted in 1881, and is designed to afford a channel of navigable width of not less than 15 feet depth at low water.

The total amount expended from the date of the first appropriation in 1852, to June 30, 1890, is $292,663.45, including outstanding liabilities.

The amount expended from the adoption of the present project in 1881, to June 30, 1890, is $58,221.68, including outstanding liabilities. The total expenditure has resulted in the extension of the pier to the 12-foot curve in the lake, securing a channel between the piers of navigable width and 12 feet in depth at extreme low water.

The operations of the fiscal year have been repairs, and renewal of

superstructure on portions of west pier and of east breakwater; tl latter is parapet form.

July 1, 1889, amount available	$9,096.
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	3,768.
July 1, 1890, balance available	5,328.
Amount appropriated by act of September 19, 1890	13,000.
Amount available for fiscal year ending June 30, 1891	18,328.
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	13,671.

(See Appendix O O 3.)

4. *Oswego Harbor, New York.*—The earliest project for the improv ment of this harbor was adopted in 1827, and proposed to inclose an ar at the mouth of the river by extending jetties from the shore into tl lake, joining the outer ends by a breakwater, but leaving an openi through which to enter the harbor.

The project was completed in 1869 and forms the present inn harbor.

The present project was adopted in 1870, and consists of a breakwat 5,800 feet in length, parallel to the old west breakwater, and 1,100 fe in advance of it. The estimated cost was $1,161,682. It was subs quently modified by the proposed construction of an east breakwat 2,700 feet in length, the reduction to 350 feet of the opening betwe the east end of the west breakwater and the north end of the ligh house pier, the construction of spurs along the face of the outer we breakwater to reduce the effect of accumulated seas, and for deepeni by dredging the inner harbor at the mouth of the Oswego River, a by the proposed removal of the east breakwater, now in progress.

The object of these improvements was to give protection to the ci docks and wharves, and to the commerce of the harbor, and make depth suitable for the heaviest draught vessels on the lakes.

The natural entrance to the mouth of the river was shallow and dif cult of access.

The total amount expended from the date of the first appropriatio in 1826, to June 30, 1890, is $1,671,998.68, including outstanding li bilities; $5,083.05, in addition, is covered by existing contract.

The amount expended from the adoption of the present project i 1870 to June 30, 1890, is $1,198,665.95, including outstanding liabilitie

The total expenditure has resulted in the completion of the originall projected harbor; the completion of the west breakwater, with the r duction of 350 feet of the opening between the east end of the we breakwater and the north end of the light-house pier; the constructio and the removal of 213 linear feet of the east breakwater; the compl tion of two spur cribs, and the deepening of the river mouth to a dept of 15 feet at low water, securing full protection to the docks and wharv west of the river mouth, and channels of entrance 16 feet deep and 35 feet wide each to the inner and outer harbors, and 15 feet deep at lo water.

Early in December, 1884, a severe northwest storm caused a breac in the west breakwater 140 feet in width, necessitating repairs for length of 100 feet each side of the breach.

The operations of the fiscal year have been repairs of damage b storm and removal of east breakwater.

July 1, 1889, amount available		$112,786.08
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$47,629.68	
July 1, 1890, outstanding liabilities	1,662.41	
July 1, 1890, amount covered by uncompleted contracts made during the fiscal year ending June 30, 1890	5,083.05	
		54,375.14
July 1, 1890, balance available		58,410.94
Amount appropriated by act of September 19, 1890		30,000.00
Amount available for fiscal year ending June 30, 1891		88,410.94
Amount (estimated) required for repairs and completion. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		162,000.00

(See Appendix O O 4.)

5. *Sackett's Harbor, New York.*—The project for the improvement of this harbor was adopted in 1881, and proposed the deepening of the harbor over an area of about 15 acres to a depth of 12 feet at low water. The depth previously existing was less than 8 feet over a large part of its area.

In 1826 and 1828 the sum of $6,000 was expended in clearing and deepening the harbor.

The total amount expended from 1826 to June 30, 1890, is $14,279.51. The amount expended from the adoption of the present project to June 30, 1890, is $8,279.51, and has resulted in the removal of 24,010 cubic yards of sand, mud, and gravel, and in the construction of a stake and fascine jetty 164 feet in length, with a mooring-crib 18 feet square at its inner end, to shelter the basin and prevent gravel drift into it. With the completion of that work the harbor had a depth of 12 feet at low water over about 6 acres of its area, except in a small part where the presence of rock in place limited the depth to a little less than 12 feet.

There have been no operations during the fiscal year.

July 1, 1889, amount available	$556.20
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	23.44
July 1, 1890, balance available	532.76
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	13,000.00

(See Appendix O O 5.)

IMPROVEMENT OF OGDENSBURG HARBOR ON THE RIVER ST. LAWRENCE, OF HARBORS ON LAKE CHAMPLAIN, AND GRASS AND TICONDEROGA RIVERS, NEW YORK, AND OF OTTER CREEK, VERMONT.

Officer in charge, Maj. Milton B. Adams, Corps of Engineers; Division Engineer, Col. H. L. Abbot, Corps of Engineers.

1. *Ogdensburg Harbor, New York.*—The present project for the improvement of this harbor was adopted in 1890 and contemplates the deepening of the various channels leading from the deep water of the St. Lawrence River and that along the city front so as to afford a depth of 17 feet at extreme low water, at an estimated cost of $158,950.

When operations were commenced at this harbor the channels afforded depths of 5 to 12 feet only, and now there are three good channels, from deep water in the St. Lawrence River to the nearest docks or

wharves, in which water from 15 to 16 feet depth is afforded, and a channel 12 to 15 feet deep has been made along the city front.

The appropriation of August 11, 1888, has been pledged under contract and nearly consumed in widening and deepening the channels at this harbor.

The total amount expended from the date of the first appropriation in 1852 to June 30, 1890, has been $159,451.46, and from the adoption of the project of 1882 to that of 1890 some $40,000 were expended.

July 1, 1889, amount available	$2,507.69
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,593.61
July 1, 1890, balance available	914.08
Amount appropriated by act of September 19, 1890	42,000.00
Amount available for fiscal year ending June 30, 1891	42,914.08
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	116,950.00

(See Appendix P P 1.)

2. *Grass River (at Massena), New York.*—The project for the improvement of this river was adopted in 1881 and has for its object the formation of a channel with a least depth of 4 feet and a least width of 40 feet from the St. Lawrence River to the village of Massena, a distance of about 7½ miles by water.

The natural depth of the shoal places is about 2 feet. The act of August 2, 1882, appropriated $3,000 for this work. There remained $2,948.60 unexpended, which by act of August 11, 1888, was directed to be expended in dredging operations according to the original plan.

Work was commenced by dredging at the rapids in September, 1888, and the funds were consumed with the removal of 1,668½ cubic yards at a cost of $1.76 per yard.

A cut 800 feet long and 26 feet wide was made, which lacked about 25 feet of carrying it through the shoal, consequently navigation has as yet derived no benefit from the improvement.

Amount appropriated by act of September 19, 1890	$6,000.00

(See Appendix P P 2.)

3. *Breakwater at Rouse's Point, Lake Champlain, New York.*—The project for this improvement was adopted in 1885 and contemplates the construction of a breakwater composed of rubble and large stone on a straight line from Stony Point until the 18-foot curve in the lake is reached, a total distance of 2,000 feet.

The estimated cost of the breakwater is $110,000.

Work was commenced by contract September, 1885, and has been in progress since that time.

Three contracts have been made and completed, and there are some 1,475 linear feet of completed breakwater. The funds were consumed with the completion of the third contract in November, 1889.

The good effects of the breakwater are apparent in the increased shelter afforded at the docks and wharves.

July 1, 1889, amount available	$1,591.80
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,484.07
July 1, 1890, balance available	107.73
Amount appropriated by act of September 19, 1890	15,000.00
Amount available for fiscal year ending June 30, 1891	15,107.73

Amount (estimated) required for completion of existing project..... Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	$26,500.00

(See Appendix P P 3.)

4. *Channel between North and South Hero Islands, Lake Champlain, Vermont.*—In compliance with a resolution of the Senate of the United States, dated January 15, 1887, a report of an examination of the above channel was submitted and printed as Senate Ex. Doc. 38, Forty-ninth Congress, second session (Appendix O O 11, of the Report of the Chief of Engineers for 1887).

The proposed improvement provided for the removal of about 12,000 cubic yards (mostly bowlders) at the west end of "the Gut" channel, and 4,000 cubic yards of clay and gravel from its eastern end. The river and harbor act of August 11, 1888, appropriated $10,000 for the work, which was placed under contract at such favorable figures that that sum was found sufficient for the completion of the improvement. Operations commenced July 20 and were completed September 30, 1889. There were 17,326.04 cubic yards removed, at 49.9 cents per yard.

July 1, 1889, amount available.....	$1,405.22
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889.....	1,405.22

(See Appendix P P 4.)

5. *Breakwater at Gordon's Landing, Lake Champlain, Vermont.*—The project for this improvement was adopted in 1887, and has for its object the construction of a stone breakwater, composed of rubble and large stones, extending in a straight line to the 16-foot curve in the lake for the purpose of affording increased shelter to a landing on the west shore of Grand Isle, Lake Champlain. Construction commenced August 11, 1887, and has been progressing under contract since then.

The structure is to be terminated at 675 feet in length instead of 800 feet, as originally contemplated, and is now completed with the exception of the facing of large stones and rubble-stone core for about 135 feet at its outer end.

July 1, 1889, amount available.....	$1,035.75
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889.....	1,035.75
Amount appropriated by act of September 19, 1890.....	6,000.00

(See Appendix P P 5.)

6. *Plattsburgh Harbor, New York.*—The first appropriation for the improvement of this harbor was in 1836. The project as then adopted and the modifications that have been made since have resulted in the construction of 1,250 feet of breakwater, the protection of a portion of the beach, and the dredging of some shoal areas within the harbor.

Under the appropriation of August 11, 1888, proposals were invited and a contract made for dredging 28,000 cubic yards from the shoal areas within the harbor.

This contract was completed in November, 1889, and completes the project of 1870.

The total amount expended at the harbor to June 30, 1890, has been $150,788.82, of which amount $62,189.66 was expended since the adoption of the modified project of 1870.

July 1, 1889, amount available	$3,448.83
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,057.64
July 1, 1890, balance available	2,391.19
Amount appropriated by act of September 19, 1890	32,500.00
Amount available for fiscal year ending June 30, 1891	34,891.19

(See Appendix P P 6.)

7. *Burlington Harbor, Vermont.*—This improvement dates from 1836. Modifications of the original plan have been made from time to time so as to afford adequate protection to the increasing commercial and shipping interests of the harbor. The last modification, made in 1886, provides for further extension of the breakwater, both to the north and to the south, with its gradual withdrawal as it is prolonged into water about 30 feet deep, instead of 38 feet deep, so as to reduce the cost.

Operations during the past year consisted in the completion of the foundation for 360 feet northward extension to the breakwater, and the construction and sinking of nine crib substructures thereon. This work is under contract, and will require for its completion the construction of a stone superstructure over the above nine cribs.

The total amount expended to date has been $561,340.05, and under existing project $34,417.85.

July 1, 1889, amount available	$2,569.25
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,987.10
July 1, 1890, balance available	582.15
Amount appropriated by act of September 19, 1890	20,000.00
Amount available for fiscal year ending June 30, 1891	20,582.15
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	129,000.00

(See Appendix P P 7.)

8. *Otter Creek, Vermont.*—The project for this improvement proposes the formation of a channel of navigable width and a least depth of 8 feet from Vergennes, Vt., to Lake Champlain.

The appropriation of August 11, 1888, was applied under contract in the removal of 3,000 cubic yards from Bull Brook Bend that had filled in there since 1884, and some 15,391.65 cubic yards from other shoals, under contract with Luther Whitney, dated January 21, 1889. Operations commenced in September and were completed in November, consuming the available funds.

There has been expended to June 30, 1890, $33,700. The stream will require widening and deepening at its mouth and at several shoal places in order to carry out the project for improvement, and unfortunately the channel then afforded is not likely to prove permanent.

July 1, 1889, amount available	$260.33
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	260.33
Amount appropriated by act of September 19, 1890	5,000.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	16,646.00

(*See Appendix* P P 8.)

9. *Ticonderoga River, New York.*—The project for this improvement was adopted in 1881, its object being to afford a channel of navigable width and a least depth of 8 feet at low water from Ticonderoga village to Lake Champlain, a distance of about 2 miles.

The original estimated cost of the improvement was $42,516, and the amount expended has resulted in an improved channel, but one that is, unfortunately, far from permanent.

The appropriation of August 11, 1888, had been pledged under contract and work was progressing when the last annual report was made. The funds were consumed and the contract completed early in July, 1889.

Amount appropriated by act of September 19, 1890	$2,000.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	28,016.00

(See Appendix P P 9.)

10. *Narrows at Lake Champlain, New York and Vermont.*—The project for this improvement was adopted in 1885 and has for its object the removal of such obstructions in the channel as will afford a least depth of 12 feet and a least width of 150 feet from Whitehall to the Elbow, and 12 feet depth and 200 feet width along Cedar Mountain and across Kenyon's Bay.

The entire undertaking was estimated to cost $80,000; $45,000 have been appropriated, and the original project stands completed at a little more than half the estimated cost.

The appropriation of August 11, 1888, was pledged under contract for the removal of 60,000 cubic yards from the channel between the Elbow and Whitehall, and 40,000 cubic yards from the channel near Cedar Mountain. Work was progressing at the date of the last annual report and was completed early in September.

The officer in charge recommends the improvement of three locations between the Elbow and Cedar Mountain by dredging, and at an estimated cost of $21,000.

July 1, 1889, amount available	$4,847.86
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,908.49
July 1, 1890, balance available	2,939.37
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	18,060.63

(See Appendix P P 10.)

PACIFIC COAST.

IMPROVEMENT OF NAPA RIVER AND OAKLAND HARBOR, CALIFORNIA.

Officer in charge, Col. G. H. Mendell, Corps of Engineers, having under his immediate orders, from August 13 to November 9, 1889, Lieut. Edward Burr, Corps of Engineers, and since September 4, 1889, Lieut. H. C. Newcomer, Corps of Engineers.

1. *Improvement of Napa River, California, officer in charge, Lieut. Col. W. H. H. Benyaurd, Corps of Engineers, until September* 23, 1889.—The project is to clear away snags and overhanging trees interfering with navigation, and to dredge gravel bars to give 4 feet depth, involving about 45,000 yards of dredging.

No operations were carried on *during* the year. No expenditures were made during *the year.*

The total amount expended, there being no outstanding liabilities, is $4,385.45.

July 1, 1889, amount available	$3,114.55
July 1, 1890, balance available	3,114.55
Amount appropriated by act of September 19, 1890	10,000.00
Amount available for fiscal year ending June 30, 1891	13,114.55
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	10,100.00

(See Appendix Q Q 1.)

2. *Improvement of Oakland Harbor, California, officer in charge, Lieut. Col. W. H. H. Benyaurd, Corps of Engineers, until August* 19, 1889.—The project for this improvement included the construction of two jetties, submerged at high water, extending from the shore into the bay of San Francisco for a distance between 11,000 and 12,000 feet, the connection of San Leandro Bay with the basin of Oakland Harbor by a canal 1½ miles in length, and dredging.

The modifications since made consist in raising the jetties about a foot above high water, in increasing the width of the canal from 300 to 400 feet, and in dredging the channels to a greater extent than originally contemplated.

The original low-water depth was about two feet, admitting light-draft vessels at high water. The present low-water depth is 14 feet, admitting at high water vessels of 16 to 18 feet draft.

The operations during the past year have widened the channel below Oakland for the greater part of the distance to 300 feet, and for the remainder from 100 feet width to 225 feet, this work not being entirely completed, but under contract to be finished in a few months. The depth, which had lessened to 10 feet in a few places, was restored to 14 feet, which, with increased width, adds much to the convenience of navigation. A portion of the tidal canal was excavated, and is yet in progress under contract. Dredging the basin was executed to the extent of 495,387 cubic yards. Five thousand four hundred and forty-six and one-third tons of stone were placed on the jetties, and 25,197 square feet of dry masonry were laid. The total amount of excavation during the year, on land and by dredge, was 949,203 cubic yards. The amount of money expended to the close of the fiscal year ending June 30, 1889, was $979,247.88. The amount expended during the year ending June 30, 1890, was $189,439.81; the amount retained on contracts uncompleted is $8,936.90, and the amount covered by work to be done under these contracts is $61,780.69.

July 1, 1889, amount available	*$60,144.90
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	14,950.18
July 1, 1890, balance available	45,194.72
Amount appropriated by act of September 19, 1890	250,000.00
Amount available for fiscal year ending June 30, 1891	295,194.72
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	991,000.00

(See Appendix Q Q 2.)

*Erroneously stated in Annual Report for 1889 as $51,144.90.

3. *Survey of San Francisco Harbor, San Pablo and Suisun Bays, Straits of Carquinez, and mouths of San Joaquin and Sacramento rivers, officer in charge, Lieut. Col. W. H. H. Benyaurd, Corps of Engineers, until September* 23, 1889.—The lines of San Francisco Harbor were designated and approved by the War Department. There were no operations in the field.

In order to complete the survey of San Francisco Harbor, there remain about 100 square miles to be sounded, covering the bar and entrance. The part already completed covers about 110 square miles adjacent to the city.

July 1, 1889, amount available	$1,446.51
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	318.12
July 1, 1890, balance available	1,128.39
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	16,000.00

(See Appendix Q Q 3.)

IMPROVEMENT OF REDWOOD, SAN LUIS OBISPO, WILMINGTON, AND SAN DIEGO HARBORS, CALIFORNIA.

Officer in charge, Lieut. Col. W. H. H. Benyaurd, Corps of Engineers, having under his immediate orders Second Lieut. James J. Meyler, Corps of Engineers.

1. *Redwood Harbor, California.*—The project is to dredge Redwood Creek, adjacent to Redwood Harbor, for a distance of about 6,000 feet, so as to give a channel not less than 50 feet wide and 3 feet deep at mean low tide. This will accommodate the vessels of 60 to 80 tons trading at this port. Previous to the commencement of this work the bottom of the channel, through the stretch indicated, was on an average 3 feet above mean low tide. At the commencement of the fiscal year the creek had been dredged to within a short distance of the upper limit of the projected channel. Work was continued during July and August and the project completed.

The total amount expended on this work up to the close of the fiscal year ending June 30, 1889, was $12,986.41.

The improvement can not be considered of a permanent character. There being no tidal basin, there is a constant tendency to shoaling, due to natural causes. Operations must therefore be continued from time to time to maintain the channel in a navigable condition. An examination made in March last showed that the channel dredged in 1887 and 1889 had partially filled up, due to material brought down from the upper reach of the creek and from the sliding in of the natural banks.

Any appropriation made in the future will be expended in maintaining the dredged channel.

The total amount expended is $15,397.70.

July 1, 1889, amount available	$2,413.59
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	2,411.29
July 1, 1890, balance available	2.30

(See Appendix R R 1.)

2. *San Luis Obispo Harbor, California.*—The project is intended to secure a protected anchorage by the construction of a breakwater along

Whaler's Reef, extending from Point San Luis to Whaler's Island, and thence to a point where the outer reef rises above high water. The total length of the structure, when completed, will be 2,300 feet.

At the commencement of the fiscal year the contractor had deposited on the reef stone to the amount of 2,812 tons. The amount expended on this improvement up to the close of the fiscal year ending June 30, 1889, was $6,205.51. Succeeding operations consisted in closing the gap between Point San Luis and Whaler's Island, and in depositing stone on the line of the breakwater outside of Whaler's Island. The total amount of material deposited on the reef was 6,596 tons.

Work will be continued during the coming season upon the outer extension of the breakwater.

The estimate herewithis intended for a continuance of these operations.

The total amount expended is $24,990.70.

July 1, 1889, amount available	$123.39
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	114.09
July 1, 1890, balance available	9.30
Amount appropriated by act of September 19, 1890	40,000.00
Amount available for fiscal year ending June 30, 1891	40,009.30
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	219,900.00

(See Appendix R R 2.)

3. *Wilmington Harbor, California.*—The present project is intended to secure a depth of 16 feet at mean low tide. Previous to the commencement of the improvement there was a depth not to exceed 1 foot at the entrance at low tide. The operations have resulted in securing a channel of not less than 12 feet throughout its entire length. It is intended to still increase this depth by dredging and by extending the jetties.

Dredging operations were delayed until May, owing to the fact that reasonable bids for the work could not be obtained, though proposals were twice solicited by advertisements. A contract was finally entered into for dredging the interior channel at a rate of 55 cents per cubic yard. During the short period worked, the contractor removed 13,498 cubic yards of material.

Specifications were issued in June, inviting proposals for furnishing 16,000 tons of stone for the west jetty.

The work of dredging and of jetty extension will be carried on during the coming season, and in the future, under the existing project, to the extent of the funds made available.

The total amount expended on this work up to the close of the fiscal year ending June 30, 1889, was $741,041.21.

The total amount expended, including outstanding liabilities, is $752,005.82.

July 1, 1889, amount available		$128,958.79
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$5,714.33	
July 1, 1890, outstanding liabilities	5,250.28	
July 1, 1890, amount covered by uncompleted contracts made during the fiscal year ending June 30, 1890	40,068.50	
		51,033.11
July 1, 1890, balance available		77,925.68
Amount appropriated by act of September 19, 1890		34,000.00
Amount available for fiscal year ending June 30, 1891		111,925.68

Amount (estimated) required for completion of existing project ..... Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	$51,000.00

(See Appendix R R 3.)

4. *San Diego Harbor, California.*—The work heretofore carried on at San Diego consisted in changing the course of the San Diego River, in order to prevent the filling up of the harbor by material brought down in flood stages. A substantial levee was built across the old channel of the river near its entrance into the harbor, and a new water-way was excavated leading into False Bay.

This work was completed in 1876, since which time operations have simply consisted in keeping the levee in good condition. The total amount expended on this work up to the close of the fiscal year ending June 30, 1889, was $81,918.45.

A survey of the outer bar and entrance was made in 1887, and an estimate amounting to $394,400 was presented for dredging the middle ground near the entrance and for building a jetty on Zuninga shoals. This latter work is intended to secure a depth over the outer bar of 26 feet at mean low water.

July 1, 1889, amount available	$81.55
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	50.00
July 1, 1890, balance available	31.55
Amount appropriated by act of September 19, 1890	60,500.00
Amount available for fiscal year ending June 30, 1891	60,531.55

(See Appendix R R 4.)

IMPROVEMENT OF ENTRANCE TO HUMBOLDT BAY; OF SAN JOAQUIN, MOKELUMNE, SACRAMENTO AND FEATHER RIVERS, AND PETALUMA CREEK, CALIFORNIA.

Officer in charge, Maj. W. H. Heuer, Corps of Engineers; Division Engineer, Col. G. H. Mendell, Corps of Engineers.

1. *San Joaquin River, Stockton and Mormon sloughs, California.*—This river before improvement began had a 6 feet deep low-water channel, less than 100 feet wide to Stockton, and a channel less than 2 feet in depth, for six to seven months annually, on the upper river to Hill's Ferry.

The project adopted in 1877 had for its object the securing and maintenance by dredging of a low-water channel 100 feet wide and 9 feet deep to Stockton, and the making of cut-offs and the general temporary improvement of the upper river by wing-dams, snagging, and the partial or complete closure of some of the outlets.

Up to the close of the fiscal year, June 30, 1889, the sum of $173,034.12 had been expended.

At that time there was a channel 100 feet wide and 9 feet deep to the Stockton Slough. At the commencement of the present fiscal year this had shoaled to 6 feet, and had to be re-dredged to a depth of 9 feet, requiring the removal of 120,959 cubic yards of dredged material, which was removed from a series of cuts aggregating in length 16,198 feet, each cut averaging 50 feet in width, at a cost of 5¼ cents per cubic yard. High water in December 1889 caused work to be stopped. Its condition on June 30 is unknown, as the river is yet in a flood state. Since dredging stopped in December there has been no interruption to navigation. It is probable that in *consequence* of this exceptionally large

flood the channel in Stockton Slough has partially refilled, and in the future, as in the past, can only be maintained by annual dredging.

It is reported that during the present flood the submerged dam built at Paradise Cut in 1888, was washed away. This report has not yet been verified as the river is still in its flood stage, and is over 2 miles wide at this locality, where its normal width is less than 250 feet. If it is washed out the estimated cost of replacing it is about $14,000. A dam is also required at Laird's Slough, to close a crevasse and improve navigation on the upper river; the estimated cost of this dam is $9,570. Cut-offs are required at Head Reach and Twenty-one mile Slough.

July 1, 1889, amount available	$10,690.88
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	7,296.32
July 1, 1890, balance available	3,394.56
Amount appropriated by act of September 19, 1890	75,000.00
Amount available for fiscal year ending June 30, 1891	78,394.56

(See Appendix S S 1.)

2. *Mokelumne River, California.*—Before improvement began on this river in 1884 it was obstructed by snags and overhanging trees, causing delay and danger to navigation. The project adopted aimed at removing these obstructions, $13,000 has been appropriated, and in 1884, 1885, 1886, 1887, and 1888, $12,439.70 of this was spent and the project was completed, leaving the navigation of the river in good condition and unobstructed. No work has been done in the last fiscal year and it is reported that shoals are forming near the head of navigation at New Hope Landing. At present the river is high, and during its high stage navigation is uninterrupted. It is not believed that the improvements have caused any reduction in the rates of freight or insurance. One steamer, the *Constance*, makes three trips per week and carries all the freight offering.

July 1, 1889, amount available	$560.30
July 1, 1890, balance available	560.30

(See Appendix S S 2.)

3. *Sacramento and Feather rivers, California.*—Before improvement began on these rivers navigation was dangerous on account of snags, and on the Upper Sacramento and Feather rivers were numerous shoals, all of which were obstructions to navigation.

In 1874 a project was made for the improvement of their low-water channels, to consist of the removal of snags, scraping of bars, and the building of temporary wing-dams for concentrating the currents and reducing widths where required.

Three hundred and forty-one thousand two hundred and forty-eight dollars and fifty-three cents was expended up to June 30, 1889, and $49,338.10 has been expended during the present fiscal year. On June 30, 1889, the river was in a fairly good navigable condition, the snag-boat was at work removing snags, and completed this season's work in August 1889, having in the two months removed 705 snags and 70 overhanging trees.

In December, 1889, both rivers reached their flood stage and numerous breaks in the levees occurred. One just below and opposite Sacramento became 1,095 feet in length and had a maximum depth of 24 feet of water through it; the average depth of water in this break was 12 to 14 feet. Contracts for closing this with brush, piling and ballast

were made and the work is now secure and under perfect control. The work will probably be finished within the next ten days. A joint resolution of Congress, approved December 21, 1889, made $110,449.67, an unexpended balance heretofore unavailable, useful for removal of damages caused by recent floods. With part of this money the crevasse was closed. The snag-boat and barge were hauled out on the ways and thoroughly repaired, making them available for work when their services are required.

There has been no interruption to navigation during the past fiscal year. The recent extremely high and prolonged flood has probably caused more snags than usual to lodge in the upper river. A re-survey of the lower river is contemplated as soon as the floods subside.

The commerce of the Sacramento River above Sacramento is handled entirely by one transportation company operating 8 steam-boats and 21 barges. Their tonnage, sizes, etc., are described in the detail report. On the lower river, that is, from Sacramento to its mouth, the Southern Pacific Railroad Company runs two steamers, each about 450 tons, making one trip per day, and the California Transportation Company own and operate 5 steamers, the largest of which is 619 tons, the smallest 145 tons, and 7 barges varying from 378 to 115 tons capacity. They only run a short distance above the mouth of the river.

On the Feather River only one steam-boat is run, making one round trip per week. The boat is owned by the Southern Pacific Railroad Company.

July 1, 1889, amount available		$122,367.99
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$47,954.62	
July 1, 1890, outstanding liabilities	21,618.47	
		69,573.09
July 1, 1890, balance available		52,794.90
Amount appropriated by act of September 19, 1890		30,000.00
Amount available for fiscal year ending June 30, 1891		82,794.90

(See Appendix S S 3.)

4. *Petaluma Creek, California.*—Before improvement this creek was crooked and in places at low water was bare. In 1880 a project was made and adopted for improving it by making cut-offs and dredging a channel 50 feet wide and 3 feet deep at low-water stage. Work was done by contract and in 1884 the project was completed at a cost of $27,656.91. In 1888 the channel had deteriorated and was again dredged so as to relieve immediate wants of navigation, and $2,116.39 was spent in doing this. On June 30, 1889, the channel was in fairly good condition, and up to that date $29,983.54 had been spent on the improvement. No work has been done during the present fiscal year, though the channel has again deteriorated somewhat and steam-boat men complain of detention. One steam-boat, 294 tons, makes daily trips between Petaluma and San Francisco; 2 schooners run regularly between these two ports. The commerce is reported to be increasing.

July 1, 1889, amount available	$2,016.46
July 1, 1890, balance available	2,016.46
Amount appropriated by act of September 19, 1890	4,000.00
Amount available for fiscal year ending June 30, 1891	6,016.46

(See Appendix S S 4.)

5. *Humboldt Harbor and Bay, California.*—Prior to commencing work in 1881 the channels in Humboldt Bay were shallow and vessels sometimes had difficulty in getting to wharves in Eureka, Arcata, and Hookton. They were dredged out, a depth of 13 feet at low water was obtained to Eureka wharves, and channels having 10 feet in depth at low water were dredged to Arcata and Hookton. This was the originally adopted project, which was completed.

In 1882 a project was adopted for building a low training-wall so as to improve the entrance to Humboldt Bay. This wall was to be about 6,000 feet long, to extend from the south spit in a northwest direction out towards the bar. It was estimated to cost about $600,000, and its object was to aid the currents, to deepen the water on the bar, and to straighten the entrance to the harbor.

In 1888 contract was made for building part of the training wall, and work on this was commenced in 1889. On June 30, 1889, this work had but fairly commenced; work was continued till December, 1889, when work had to cease on account of bad weather, and was again resumed in May, 1890. The extension of ten months of time granted in the contract expires October 31, 1890.

The training-wall, or south jetty, now extends seaward from the south spit 3,039 feet. Its bottom is brush mattresses, averaging about 4½ feet in thickness and averaging about 46 feet in width. This is covered with heavy rock to keep it in place. Near the shore and 900 feet seaward this rock covering is above the level of high water, the next 384 feet is between high and low water, the next 1,756 feet is submerged. All of this jetty had to be built from a trestle work carrying engine and cars, the rails being about 15 feet above high tide.

Up to June 30, 1890, 1,605 feet of railroad track on shore has been built, 31,155 tons of rock delivered and accepted in jetty and shore protection, 18,660 cubic yards of brush mattress laid, 3,327 lineal feet of pier over water constructed. Up to the close of the fiscal year $100,864.92 has been spent on this work.

The work in its incomplete state thus far has not made any material increased depth of water, nor was it expected to do so. It has caused the north spit to erode somewhat, and there is and has been during the whole year a channel carrying 14 to 20 feet into the harbor. The fact has been established that the rock can be made to stay in the jetty and that the sand follows the jetty out as the latter is being built, thus answering the purpose of concentrating and directing the current.

The commerce of the port is carried by two steamers running from San Francisco to Eureka, each making two regular trips per week. Also, several steam schooners and numerous sailing-vessels engaged principally in the lumber trade.

July 1, 1889, amount available	$6,819.49
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	5,844.65
July 1, 1890, balance available	974.84
Amount appropriated by act of September 19, 1890	80,000.00
Amount available for fiscal year ending June 30, 1891	80,974.84
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	257,500.00

(See Appendix S S 5.)

IMPROVEMENT OF THE ENTRANCE TO COOS BAY—IMPROVEMENT OF YAQUINA BAY, OF COQUILLE RIVER, OF UMPQUA RIVER, OF TILLAMOOK BAY AND BAR, OREGON; OF UPPER COLUMBIA AND SNAKE RIVERS, OREGON AND WASHINGTON; OF CHEHALIS RIVER, AND OF SKAGIT, STEILAQUAMISH, NOOTSACK, SNOHOMISH, AND SNOQUALMIE RIVERS, WASHINGTON.

Officer in charge, Capt. Thomas W. Symons, Corps of Engineers; Division Engineer, Col. G. H. Mendell, Corps of Engineers.

1. *Coquille River, Oregon; in charge of Capt. Willard Young, Corps of Engineers, until December* 4, 1889.—At the time the work of improvement was begun the entrance to the Coquille River was considered very dangerous. It was by a long, tortuous, and narrow channel skirting the south headland, studded with rocks from beyond the bar on the outside to a distance of one-half mile inside. The depth at low water over the bar was only about 3 feet, and the position of the bar channel was constantly shifting. The channel sometimes, at long intervals apart, broke through the north spit, but did not remain long in this position. The entrance at such times was comparatively safe, and the channel was at its very best. The mean rise of tide was 4.1 feet. The plan of the improvement is to construct two parallel high-tide jetties, 800 feet apart, running out to sea a sufficient distance to open and maintain a channel over the bar with a least depth of 8 feet at low water, the north jetty starting from Rackliffe Rock and the south jetty from a point on the left bank inside the entrance. The cost of this work, as estimated in 1878 by Maj. J. M. Wilson, is $164,200.

The law of August 11, 1888, authorized in addition $5,000 to be expended for snagging between Coquille City and Myrtle Point.

The amount which had been expended on the project for the improvement of the mouth of the Coquille to June 30, 1889, was $67,822.67. The channel through the north spit was opened in 1882, after the construction of about 1,000 feet of temporary jetty, and soon after the old channel was completely filled up and the jetty across it covered with sand and drift. The new channel when well opened gave a depth of 7 feet at low water over the bar. During 1884 some of the temporary jetty was destroyed by drift, and the adjacent fill was washed out, so that a portion of the outflow escaped uselessly to the south among the rocks, causing a shoaling up of the channel over the bar to a depth of 5 feet. In 1885 the jetty was repaired and extended out to a length of 1,523 feet, giving a channel depth of about 6 feet at low water. During the season of 1886–'87 an extension of 403 feet was made to the jetty pile-work, and the jetty was partly completed by the addition of stone. During 1889 the jetty was still further strengthened and extended, with the result that the ordinary high-water depth on the bar was 11 feet, while during a part of the time a depth of 20 feet was obtained.

The amount expended during the year ending June 30, 1890, was $7,025.81. Of this amount about $4,000 was expended in snagging on the river between Coquille City and Myrtle Point, under the clause in the appropriation bill which authorized the expenditure of $5,000 for this purpose. The results of the work already done at the mouth of the Coquille are in the highest degree satisfactory, there being now a straight channel out to sea with a depth of 10 feet at low water. From the outer end of the jetty a deposit of sand tails out, forming a well-defined low sand jetty or training-wall in direct prolongation of the jetty, and on the north side sand has been deposited parallel with the jetty, and nearly up to low water, *at a distance* of about 800 feet from it,

forming also a low sand training-wall, which altogether direct the ebbing and flooding tides and river waters in a straight and deep channel out over the bar to sea. This result has been hastened very materially by the removal of the mid-channel rock just inside the entrance, which bar has so long been a terror to mariners and the cause of many accidents. This rock was drilled and prepared for blasting, but the appropriations became exhausted before this was done. Recognizing the importance of its removal and the fact that the best time of the year to do it was during the low tides of June, the citizens on the river contributed the necessary labor, powder, and other material for its removal, this office supplying only the blasting-machine and the skilled supervisor, and on June 5 the blast took place successfully, and the rock was entirely demolished and disappeared.

The snagging and bar scraping done on the river between Coquille City and Myrtle Point was productive of great good to the navigation of the river. The freshets of the last winter and spring (unprecedented in volume) have, however, again deposited many snags in the river which should be removed.

The appropriations made in six acts amount to $105,000.

July 1, 1889, amount available		$4,651.78
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$4,500.26	
July 1, 1890, outstanding liabilities	45.50	
		4,545.76
July 1, 1890, balance available		106.02
Amount appropriated by act of September 19, 1890		30,000.00
Amount available for fiscal year ending June 30, 1891		30,106.02
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		64,000.00

(See Appendix T T 1.)

2. *Entrance to Coos Bay, Oregon, in charge of Capt. Willard Young, Corps of Engineers, until December* 4, 1889.—The obstructions which existed at the entrance to this harbor before the works of improvement were begun consisted, first, of the outer bar, which is of sand and is shifting in character, and secondly, of the inner shoals formed by the sands which accumulate in the spring, summer, and autumn during the times when the northwesterly winds prevail.

Under the action of these winds the spit on the north side advanced toward the south, contracting the navigable passage under Coos Head to a very narrow width, and usually making the outer channel follow the west side of the spit in a long and tortuous course across the bar.

The channel had at times broken through the north spit on a line the general direction of which is from Fossil Point to a point just to the north of Coos Head. It was then direct; the depth of water was greatest, and vessels could enter or go out without trouble. The mean rise of tide above the plane of reference was 5.6 feet. The project for this improvement, adopted in 1879, is to construct, at an estimated cost of $600,000, a jetty of wood and stone, as may be found best, from a point 250 yards below the northern extremity of Fossil Point, on a line towards the east end of Coos Head; this line in plan, curving so as to be directed at its outer end to the head, or a little to the north of it.

The object is to prevent accretion to the south end of the sand-spit on

the north side of the entrance, and to open and maintain a deeper and more direct channel across the outer bar.

A Board of Officers of the Corps of Engineers has submitted a report embodying an additional project and estimate of the cost of completing it for the improvement of the entrance to the harbor of Coos Bay. Their report is herewith: This Board recommend that the present jetty be not further extended, but that two jetties be built; one from Coos Head, and one from the southern end of the north spit out towards the bar, ending at a distance apart of about 1,500 feet.

The estimated cost of the work proposed by the Board of Engineers is $2,466,412.20. This report also alludes to the desirability of holding the drifting sands of the north spit.

The total amount expended in improving the entrance to Coos Bay to June 30, 1889, was $140,786.97.

The jetty had been built to a total length of 1,761 feet, but a considerable portion of this consisted simply in a paving of heavy stone on the bottom in advance of the jetty to prevent scour.

The results of the jetty thus far had been to keep the channel over the bar from varying its position as much as formerly, and to commence an erosion of the north spit.

The bar channel had been constantly improving since the commencement of work on the jetty. Amount expended during fiscal year ending June 30, 1890, was $56,673.44. During the year there were placed on the jetty and jetty extension 38,845 cubic yards of stone as measured on barges.

The result of dumping this mass of rock in what was formerly the mid-channel of the Bay has been to cause a marked erosion of the north spit, and to create a tendency on the part of the waters to break through the north spit just below the end of the spit which is above high water.

The channel is in a more northerly position than it was a year ago, and is somewhat shoaler, due to the fact that time enough has not elapsed for the currents to have scoured out a new channel under direction of the jetty. When the north spit has become a little more eroded and the direction of the channel straightened, it is hoped that the channel will deepen materially.

The appropriations made in seven acts amount to $356,750.

July 1, 1889, amount available		$7,099.62
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$3,297.6	
July 1, 1890, outstanding liabilities	390.00	
		3,687.36
July 1, 1890, balance available		3,412.26
Amount appropriated by act of September 19, 1890		125,000.00
Amount available for fiscal year ending June 30, 1891		128,412.26
Amount (estimated) required for completion of project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		2,341,412.20

(See Appendix T T 2.)

3. *Umpqua River, Oregon, in charge of Capt. Willard Young, Corps of Engineers, until December* 4, 1889.—Just below Scottsburgh, the head of navigation on the Umpqua River, are five sandstone bars or ledges 12 feet to 15 feet wide, and submerged from 1 foot to 2 feet at low tide on a low-river stage. They are separated by pools about 150 feet wide and from 5 to 10 feet deep *at low water.*

The Secretary of War having authorized the expenditure of the balance remaining of the appropriation of March 3, 1871, viz, $4,685.89, in improving the river below Scottsburgh, a project was submitted and approved in 1885 for making, at an estimated cost of $4,056, a channel 50 feet wide and 3 feet deep at low water through the rock ledges above described by drilling and blasting the rock and removing the broken pieces to deep water in the pools.

The amount expended on the project to June 30, 1889, was $4,675.14.

The result obtained was an increase in the depths of water over some of the reefs through a channel 50 feet wide from 1 foot at low, which formerly existed, to 2 feet at low water. The amount expended during fiscal year ending June 30, 1890, was $1,983.28. The result obtained has been to increase the extent of the low-water navigable channel above mentioned to a depth of 2 feet.

The appropriations made in three acts amount to $33,500.

July 1, 1889, amount available	$2,010.75
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,983.28
July 1, 1890, balance available	27.47
Amount appropriated by act of September 19, 1890	9,000.00
Amount available for fiscal year ending June 30, 1891	9,027.47

(See Appendix T T 3.)

4. *Yaquina Bay, Oregon, in charge of Capt. Willard Young, Corps of Engineers, until December* 4, 1889.—The usual prevailing depths over the bar at low water, before improvement, were from 7 feet to 8 feet. Three distinct channels existed, known as the north, middle, and south channels. The south channel was the one mostly used, but was rendered dangerous by the presence of rocks. The middle channel, though free from rocks, was usually the shoalest of the three, and so was little used. The north channel, besides being long and tortuous, was so studded with rocks as to be considered unnavigable. Owing to the shifting nature of the bar, these channels were constantly changing both in position and depth. The mean rise of tide was 7.1 feet. The project adopted in 1881 was to run out a dike or jetty on the south side of the entrance, so as to cause the south channel to shoal up and the flow to be deflected northward, with a view to opening and maintaining the central channel with a least depth of 17 feet at high water.

As originally projected, the dike was to start from near low-water line and run out into the sea, a distance of 2,500 feet, and was to rise to 2 feet above mean low water. The beach, on the line of the jetty from high-water level, was to be protected by sinking gabions in the beach with sand heaped over them, and by covering the surface with a layer of mattresses and stone.

The stone for the jetty was to be deposited in place from barges, and cribs were to be used if practicable. It was found, however, that cribs could not be used on account of the strong currents and high seas, and that the ocean swell, even in quiet weather, was too great to permit of the use of stone barges. Accordingly the jetty had to be built from the shore end, by carrying the stone out over a tramway, and was begun at high-tide line instead of at low-tide line, thus making the total projected length of the jetty, in 1881, 3,700 feet.

In 1884 the jetty was extended shoreward a distance of 316 feet to close up a gap that had been washed out by the sea, making the total *projected* length of the jetty at that time about 4,000 feet.

The present project, adopted in 1888, is to raise the south jetty to full high water without extending it seaward, thus making its total length 3,748 feet, and to construct a midtide jetty on the north side of the entrance, about 2,300 feet in length, extending from the north head along and behind the reef, putting out from the head to a point opposite the end of the south jetty and distant from it about 1,000 feet.

Amount expended to June 30, 1889, was $332,631.25.

At that date the south jetty had been completed to its entire length, as projected by the Board of Engineers, and the north jetty to a length of 300 feet, and work was being actively carried on.

The result on the harbor entrance was to keep the bar channel more in one place and to increase the depth over the bar.

The south channel had been permanently shut off and the tendency of the waters to go to the north restricted.

Amount expended during the year ending June 30, 1890, was $50,867.12.

The south jetty was built up to full high water without being extended, about 18,040 tons of stone being used.

The north jetty was extended 820 feet in length; 12,980 tons of stone being used on this extension.

The result of all this work has been to cause the channel to run in a direct line out to sea and to maintain an ordinary depth of 11 to 12 feet at low water.

Appropriations have been made for this improvement amounting to $550,000.

July 1, 1889, amount available		$43,368.75
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$41,867.12	
July 1, 1890, outstanding liabilities	1,154.00	
		43,021.12
July 1, 1890, balance available		347.63
Amount appropriated by act of September 19, 1890		165,000 00
Amount available for fiscal year ending June 30, 1891		165,347.63
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		145,000.00

(See Appendix T T 4.)

5. *Tillamook Bay and Bar, Oregon. In charge of Capt. Willard Young, Corps of Engineers, until December* 4, 1889.—The channel over the bar is direct and shifts but little, so that the bar is considered one of the safest on the Oregon coast. A fair depth of water is maintained throughout most of the year, and vessels drawing as much as 13 feet can usually enter without difficulty. The bay at low tide consists of three channels, running through sand and mud flats. These channels are of fair depth near the entrance, but gradually shoal up, giving depths of only 1 or 2 feet near the head of the bay. Tillamook, the principal town of the region, is situated on a tidal slough above the head of the bay, and can be reached only by light-draught vessels at high tide. A special project for the expenditure of the money appropriated by the act of August 11, 1888, has been approved. This consisted in making a survey of the bar and entrance and the construction of longitudinal and spur dikes and shore-protection works to deepen the water over Dry Stocking Bar, at the mouth of Hoquarton Slough, and to remove snags and overhanging trees from Hoquarton Slough. Amount expended to June *30, 1889, $47.78.*

No work except of a preliminary character was done, and no results obtained.

Amount expended during year ending June 30, 1890, was $4,687.76.

During the year 1,148.5 feet of sheet-pile dikes and 448.5 feet of pile and brush revetment work were built at Dry Stocking Bar.

The act of August 11, 1888, appropriated $5,200 for this improvement.

July 1, 1889, amount available	$1,483.41
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,018.95
July 1, 1890, balance available	464.46
Amount appropriated by act of September 19, 1890	500.00
Amount available for fiscal year ending June 30, 1891	964.46
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	5,500.00

(See Appendix T T 5.)

6. *Upper Columbia and Snake rivers, Oregon and Washington, in charge of Maj. W. A. Jones, Corps of Engineers, until October* 31, 1889, *and of Maj. Thomas H. Handbury, Corps of Engineers, until May* 31, 1890.—Under the above head it has been deemed proper to officially include the continuous Columbia and Snake rivers from Celilo at the head of The Dalles to Lewiston.

The Upper Columbia and Snake form a continuous line of navigable rivers, but broken by many rapids, rendering navigation difficult and dangerous.

These rapids are in nearly every instance caused by rocky bars with occasional bowlders, and the channels were crooked and narrow.

Before improvement the ruling depth of low water was 2 to 3 feet on many of these bars, some of which were practically impassable at low water.

The *Col. Wright*, 302 tons, built in 1888, was the first steamer to run between Celilo and Lewiston; since then many other steamers have run on the route.

Previous to 1877 $120,000 had been appropriated for the work of improvement, and had been expended in survey and rock removal at the principal rapids.

In 1877 a project was made for the improvement of the Upper Columbia and Snake rivers, consisting of removing rock bowlders and rocky reefs and scraping gravel bars to secure a low-water channel of 5½ feet in the Columbia as far as the mouth of the Snake, and 4½ feet in the Snake as far as Lewiston. The estimated cost of this work was $132,000.

There have been appropriated up to date for Upper Columbia River $105,000, for Upper Columbia and Snake rivers, $151,000, making an aggregate of $256,000.

Amount expended on project to June 3, 1889, was $129,704.39.

Snake River between Lewiston and the mouth has ordinary widths of 1,000 feet, a slope of 2.48 feet per mile, and a discharge of 26,000 cubic feet per second. All the bars have been improved to the extent of being no longer dangerous to competent navigators who are acquainted with them, and with the exception of Long Crossing Bar, on the Snake, the required depth below the datum assumed at the time, the project was adopted, has been obtained. This datum, however, has been lowered about 1½ feet, so that the ruling low-water depth on Snake River

outside of Long Crossing Bar is now 3 feet. This depth I consider sufficient for present purposes.

Expended during year ending June 30, 1890, $991.36, the larger portion of which was expended in paying outstanding liabilities incurred previous to beginning of the year.

July 1, 1889, amount available		$905.38
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$601.13	
July 1, 1890, outstanding liabilities	23.00	
		624.13
July 1, 1890, balance available		281.25
Amount appropriated by act of September 19, 1890		20,000.00
Amount available for fiscal year ending June 30, 1891		20,281.25

(See Appendix T T 6.)

7. *Chehalis River, Washington, in charge of Maj. Thomas H. Handbury, Corps of Engineers, until May* 31, 1890.—The navigable portion of the Chehalis River is about 90 miles in length from Claquato to its mouth. This may well be considered in three sections.

(1) From the mouth to Montesano, a distance of 12 miles, there is about 18 feet of water at high water, and coasting vessels traverse this portion of the river.

(2) From Montesano to Elma, 16 miles, the river is affected by the tides and has sufficient water for a channel all the year round. But navigation is obstructed by logs and fallen trees.

(3) Above Elma, the river is practically blockaded during the summer and fall by snags, shoals, and a general lack of water. At this time, the river is a succession of shoals and pools. On many of the shoals, the depth is reported to be only from 6 to 12 inches.

The plan of improvement contemplates removal of snags, overhanging trees, jams, drift heaps, shoals, and other obstructions to navigation.

Amount expended to June 30, 1889, was $8,667.14. During the year ending June 30, 1889, 60 snags and 5 overhanging trees were removed, and navigation to this extent improved. From the nature of the work, no results of a permanent nature affecting the regimen of the river were obtained. Amount expended during fiscal year ending June 30, 1890, was $1,006.77. During the year 56 snags were removed, and the navigation of the river rendered safer thereby.

Thirteen thousand dollars has been appropriated for this work.

July 1, 1889, amount available	$1,332.86
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,006.77
July 1, 1890, balance available	326.09
Amount appropriated by act of September 19, 1890	3,000.00
Amount available for fiscal year ending June 30, 1891	3,326.09

(See Appendix T T 7.)

8. *Skagit, Steilaquamish, Nootsack, Snohomish, and Snoqualmie rivers, Washington, in charge of Maj. Thomas H. Handbury, Corps of Engineers, until May* 31, 1890.—The waters of these rivers all rise in the Cascade Range, and flow to the west into Puget Sound, between the 48th and 49th parallels of latitude.

In their original condition, they carried water enough for the purpose of steamer navigation, but *were obstructed* by snags, fallen trees,

and log jams. They were the great highways of the country, traveling on land being almost impossible on account of the heavy timber, dense underbrush, and fallen logs.

The Snoqualmie is a branch of the Snohomish.

The aggregate length of all is estimated to be about 250 miles.

The plan of improvement contemplates the removal of snags, logs, trees, and other obstructions to their navigation. For this purpose a snag-boat, with an outfit of tools and appliances, has been provided. This boat passes from one river to another, doing service in each as far as the necessities of its commerce require, and the amount of the funds appropriated will admit.

With the funds that have been appropriated, this snag-boat and outfit have been provided, and a large number of snags, jams, overhanging trees, and other obstructions to their navigation removed. These, with the trees that from time to time fall into the rivers, will furnish constant employment for the snag-boat for several seasons.

In this class of work no permanent results are arrived at or obtained. The constantly recurring snags and fallen trees, etc., are required to be constantly removed. The rivers have been kept open for navigation, and many of the perils of navigation have been removed.

Sixty-nine thousand five hundred dollars has been appropriated for these rivers.

July 1, 1889, amount available	$4,117.90
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	813.07
July 1, 1890, balance available	3,304.83
Amount appropriated by act of September 19, 1890	12,000.00
Amount available for fiscal year ending June 30, 1891	15,304.83

(See Appendix T T 8.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENT, TO COMPLY WITH REQUIREMENTS OF RIVER AND HARBOR ACT OF AUGUST 11, 1888.

It appearing from the preliminary examination made by the local engineer that the following localities are worthy of improvement, and the public necessity therefor being apparent from the facts and reasons reported, which are concurred in by the Chief of Engineers, Captain Young was charged with and completed their survey, the results of which were transmitted to Congress and printed in Ex. Doc's. of the Fifty-first Congress, first session.

1. *Young's River and its tributary, Klaskuine River, Oregon.*—Printed as House Ex. Doc. 69. (See also Appendix T T 9.)

2. *Nehalem Bay and Bar, Oregon.*—Printed as House Ex. Doc. 70. (See also Appendix T T 10.)

3. *Siuslaw River and Bar, Oregon.*—Printed as House Ex. Doc. 71. (See also Appendix T T 11.)

It appearing from the report of the preliminary examination made by the local engineer, Captain Young, that *Umpqua River, Oregon, between Scottsburgh and the mouth,* is worthy of improvement, he was charged with its survey. The survey having been completed by his successor, Captain Symons, the results were transmitted to Congress and printed as House Ex. Doc. 199, Fifty-first Congress, first session. (See also Appendix T T 12.)

IMPROVEMENT OF THE MOUTH OF THE COLUMBIA RIVER, OREGON AND WASHINGTON—CONSTRUCTION OF CASCADES CANAL, COLUMBIA RIVER—IMPROVEMENT OF THE COLUMBIA AND WILLAMETTE RIVERS BELOW PORTLAND, OREGON; OF THE UPPER WILLAMETTE RIVER, OREGON; OF THE COWLITZ RIVER, WASHINGTON; WATER-GAUGES ON THE COLUMBIA RIVER.

Officer in charge, Maj. Thomas H. Handbury, Corps of Engineers, having under his immediate orders Lieut. Edward Burr, Corps of Engineers; Division Engineer, Col. G. H. Mendell, Corps of Engineers.

1. *Mouth of the Columbia River, Oregon and Washington.*—The project under which this work is being carried on was adopted in 1884. It contemplates providing a channel across the Columbia River bar, having a depth of 30 feet at mean low tide. This is to be effected by concentrating the water flowing over the bar and increasing the resultant currents to such a degree as to procure the desired depth. Any work for accomplishing this end must be more or less tentative in its character. The work which is now in progress is the building of a low-tide jetty starting from Fort Stevens, on the South Cape, and extending in a westerly direction, with a slight curve to the south, out across Clatsop Spit, for a distance of 4½ miles, more or less, as circumstances may require, to a point about 3 miles south of Cape Hancock (Disappointment). This jetty is constructed of stone, resting upon a mattress foundation about 40 feet wide and from 2½ to 5 feet thick. The stone extends to the level of the mean lower low water. The materials thus far have been placed in position from a jetty tramway, supported upon piles driven along the line of the jetty, and about 24 feet above the level of low tide. This tramway is a double track 3-foot gauge railroad, the tracks being 13 feet between centers. The materials are landed at the wharf and transported to place over these tracks, which are built in advance of the main work.

Before the commencement of this work the channel or channels over the bar were very capricious in location and variable in dep h. The depths were from 18 to 21 feet and the channels varied in number from one to three, and in position through nearly 180°, from Cape Disappointment around to Point Adams.

A thorough hydrographic survey was made of the bar at mouth of the river in September and October last. A comparison of this with the survey of 1885, made about the time the jetty was commenced, shows that great changes have taken place in the interval between the two surveys. The most marked change in the interests of navigation is the entire disappearance of what was known as the Middle Sands. The same channel-depth over the bar that was then available for a width of 1½ miles is shown by the survey of last fall to be available for a width of 5 miles. This depth was from 18 to 22 feet at a mean of lower low waters. A good 22-foot channel was shown to be available. A few soundings taken during the latter part of May show this depth to be increasing, and that there is now a straight out and in channel with 25 feet at low water. In 1885 the distance between the 30-foot curves on the outer and inner sides of the bar was 1½ miles. The more recent soundings show this distance to be now only one-half mile.

The jetty proper is now under construction for a little more than 3¼ miles, being an addition of 1¾ miles since last report. Rock has been dumped in to a height of mean low water over about 3 miles of this distance. There is now a little less than 1¼ miles of jetty tramway to be constructed.

The effect of the jetty already constructed is now very marked in the building up of Clatsop Spit and in the concentration of the outflowing waters over the bar.

In the vicinity of the jetty large accretions have taken place both on the north and south sides.

Thus far all the conditions have been favorable for accomplishing the object of this work and the results have been very satisfactory.

The amount expended including outstanding liabilities, is $841,049.

July 1, 1889, amount available		$173,247.08
Amount appropriated by act of February 22, 1890		75,000.00
		248,247.08
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$197,085.00	
July 1, 1890, outstanding liabilities	1,854.93	
July 1, 1890, amount covered by uncompleted contracts made during the fiscal year ending June 30, 1890	27,855.29	
		226,795.22
July 1, 1890, balance available		21,451.86
Amount appropriated by act of September 19, 1890		475,000.00
Amount available for fiscal year ending June 30, 1891		496,451.86
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		525,000.00

(See Appendix U U 1.)

2. *Construction of canal at the Cascades, Columbia River, Oregon.*—The general scope of the improvement which it is desired to effect at the Cascades of the Columbia River includes a reach of about 4½ miles, where the river rushes through a narrow gorge in the Cascade Mountains. The fall in the distance is about 45 feet at high water and 36 feet at low water. The principal obstruction to navigation occurs at the upper end of the reach, known as Upper Cascades. The project for the improvement contemplates that the river should be improved below the Upper Cascades by removing bowlders and projecting points in the bed and banks, so as to give good navigable water from its lowest up to a 20-foot stage. The fall at the Upper Cascades is to be overcome by digging a canal about 3,000 feet in length across the neck of a low projecting spur around which the river is forced at the entrance to the gorge, and placing in this a lock and other suitable structures which would permit of the passage of boats up to a 20 foot stage of water in the river, this lock and canal to be so arranged that, should the future necessities of commerce so demand, additional structures may be added which will permit of navigation at much higher stages.

The first part of this project, that of improving the river below the foot of the Upper Cascades, is essentially finished.

The difference of level between the head and foot of the canal as now established is 15 feet at high water and 24 feet at low water, and the difference in height between high and low water at the foot is 54 feet and at the head 45 feet.

The plan on which the future work in the canal, with its lock and accessories, is to be prosecuted has for its object to make this portion of the river available for navigation to a stage up to 20 feet at the earliest possible moment with the funds that are from time to time appropriated for the purpose.

The difference of level is to be overcome by a lock with available chamber of 462 feet by 90 feet.

The excavation for this chamber and the upper and lower canals leading to it, for their side walls and for the masonry of the several lock and guard-gates, is substantially finished, with the exception of the upper and lower bulkheads, the portions that lie outside of these. There is in the neighborhood of 250,000 cubic yards in these excepted portions. A large extent of the side slopes of the canal above what will be the ordinary water-line has been revetted with a dry stone wall, and considerable progress has been made on the vertical side-walls at the upper and lower ends of the canal. The lock-chamber is now ready for its side-walls and for the masonry of its gates, also that of the upper and lower guard-gates. The concrete foundation on the bed-rock is prepared for the masonry of the lower lock and guard-gates and for the lower miter-sills. The granite miter-sills, hollow and recess quoins, and valve settings to be used in this masonry have been purchased, and enough are cut to raise it about 8 feet. A large quantity of basalt dimension stones to be used in this structure are on hand and cut ready for setting.

To complete the canal, all the masonry necessary to lock and guard gates and the side-walls of the lock is yet to be constructed, the gates are all to be provided, and the machinery for manœuvering them. The masses of earth which form the upper and lower bulkheads to the present lock-pit are to be removed.

At the commencement of the fiscal year there was available for the prosecution of this work $80,512.33. The work of the year was in the excavation of bed-rock with picks and gads and covering the same with concrete for masonry foundation; building side-walls for lower tail-bay, and cutting granite and basalt dimension stones for gate masonry.

One million four hundred and thirty-four thousand eight hundred and forty-six dollars and five cents have been expended.

July 1, 1889, amount available	$80,512.33
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	72,858.38
July 1, 1890, balance available	7,653.95
Amount appropriated by act of September 19, 1890	435,000.00
Amount available for fiscal year ending June 30, 1891	442,653.95
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	1,115,000.00

(See Appendix U U 2.)

3. *Columbia and Lower Willamette rivers below Portland, Oregon; in charge of Maj. W. A. Jones, Corps of Engineers, until October* 31, 1889.—The object of this improvement is to make and obtain a navigable channel from the city of Portland, Oregon, to the sea, having a low-water depth of 20 feet. There is included in the reach 12 miles of the Willamette River and 98 miles of the Columbia, measured along the deep-water channel. Before the commencement of the improvement the low-water depth of channel at some of the shoalest places was between 9 and 15 feet. During the last season a depth of 20 feet was attained.

The original project under which this improvement is now carried on was adopted in 1877, but has been extended and modified somewhat since that time. It contemplates that a navigable low-water channel,

having a depth of 20 feet, shall be maintained by means of permanent constructions, which shall protect the banks, contract the water-way, direct the currents, and control the amount of water that shall pass through sloughs, having a detrimental influence upon the main channel. While these constructions are being put in place, and until their influence is fully developed, the dredging of shoal places, to give temporary relief, will be resorted to. The amount expended since the adoption of the present project in 1877 is $541,600.50.

At the beginning of the year the available balance of the appropriation was so small that it was deemed advisable to hold it for expenditure in giving temporary relief to navigation over such bars and shoal places as might prove troublesome to navigation during the low-water season.

In pursuance of this object 16,000 cubic yards of sand were removed from the channel at St. Helen's Bar, 17,000 at Walker's Island, 61,000 at Post-Office Bar, and 37,600 at Martin's Island.

July 1, 1889, amount available	$37,623.34
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	29,843.13
July 1, 1890, balance available	7,780.21
Amount appropriated by act of September 19, 1890	100,000.00
Amount available for fiscal year ending June 30, 1891	107,780.21

(See Appendix U U 3.)

4. *Willamette River above Portland, Oregon; in charge of Maj. W. A. Jones, Corps of Engineers, until October* 31, 1889.—The project for this improvement was adopted in 1878 and extended in later years. It consisted in snagging operations, bar scraping, and sluicing-contraction of water-way over shoals, and rock removal. Its object is to give easy navigation for light-draught vessels from Portland to Eugene City, Oregon, and in 12 miles of tributaries, making in all a distance of 184 miles. The mouth of the Yamhill River, 40 miles above Portland, was the head of an inconvenient low-water navigation in a draught of 2½ feet; only 1 foot could be carried above.

During the low water of last season, which was the lowest known, a channel of 26 inches in depth was maintained to Independence, 82 miles above Portland. At one time there was but 23 inches on the lower miter-sill of the locks at Oregon City.

At the commencement of the fiscal year there was a balance of $4,036.48 available for this work.

During July, August, and September the snag-boat *Corvallis*, with a small crew, worked on the river as high up as Buena Vista, 90 miles above Portland. The bar at this point stopped farther progress up the river. From here down a least channel depth of 26 inches was obtained. A depth of 34 inches was obtained to Salem. Work was done by this boat at the following bars: Canadianis, Christman's, Fairfield, Mathemey's, Lone Tree, McCloskey's, Rice's, and Eda. During the season 138 snags were removed.

This stream is of such a character that a certain amount of work will be required every season to keep it in anything like a reasonable condition for boating. The channels and bars are constantly changing and exposing new rocks, snags, and other obstructions at every change. A small force with suitable boat and outfit can be very profitably employed during all low stages of the water in closing sloughs, building *wing-dams*, scraping bars, and removing snags and rocks.

July 1, 1889, amount available	$4,036.48
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	3,836.27
July 1, 1890, balance available	200.21
Amount appropriated by act of September 19, 1890	11,000.00
Amount available for fiscal year ending June 30, 1891	11,200.21

(See Appendix U U 4.)

5. *Cowlitz River, Washington; in charge of Maj. W. A. Jones, Corps of Engineers; until October* 31, 1889.—The project for the improvement of this river contemplates a removal of the sand-bars, snags, overhanging trees, rocks, and other obstructions in the channel from its mouth to a distance of about 50 miles above. Work has been done to Toledo, about 30 miles above the mouth. The ruling navigable depth prior to improvement was 14 inches over this reach; it is now 36 inches. The total amount that was appropriated prior to the act of September 19, 1890, for the improvement of this river was $11,000. This amount was all expended prior to the commencement of the present fiscal year. No other funds having been made available no work was done during the year.

Amount appropriated by act of September 19, 1890	$8,000.00

(See Appendix U U 5.)

6. *Gauging waters of the Columbia River, Oregon.*—The object of these gaugings is to ascertain and keep a record of the fluctuations of the Columbia River with the view to gathering information that may be useful in works of improvement on the river, and also by gauges established at various points to indicate to pilots, captains, and others interested in navigation the stage of water on crossings and places of difficult navigation.

A self-registering gauge has been in operation at Astoria, Oregon, during the entire year. Daily sheets were exhibited on a bulletin board in that city, which exhibit to pilots and others interested in the condition of the bar at the mouth of the Columbia River the stage of water and the degree of roughness of the bar. These are of great service to commerce.

July 1, 1889, amount available	$2,085.17
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	608.68
July 1, 1890, balance available	1,476.49

(See Appendix U U 6.)

EXAMINATION AND SURVEY FOR IMPROVEMENT, TO COMPLY WITH REQUIREMENTS OF RIVER AND HARBOR ACT OF AUGUST 11, 1888.

It appearing from the report of the preliminary examination made by the local engineer, Major Jones, that *Upper Columbia River, Washington Territory, between Walula and British line,* is worthy of improvement he was charged with its survey. The survey having been completed by his successor, Major Handbury, the results were transmitted to Congress, and printed as House Ex. Doc. 238, Fifty-first Congress, first session. (See also Appendix U U 7.)

SUPERVISION OF THE HARBOR OF NEW YORK.

The office of the supervisor of the harbor of New York was created by act of Congress approved June 29, 1888, entitled "An act to prevent obstructive and injurious deposits within the harbor and adjacent waters of New York City by dumping or otherwise, and to punish and prevent such offenses."

Under the provisions of section 5 of the act a line officer of the Navy was designated to discharge the duties created by the act, under the direction of the Secretary of War. On May 23, 1889, the Secretary of War directed that all communications in connection with these duties should be addressed to him through this office, and on February 1, 1890, he further directed that the powers conferred upon him by the act should be exercised through the Chief of Engineers.

The report of Capt. W. A. Kirkland, U. S. Navy, supervisor of the harbor, describing the operations in his charge for the fiscal year ending June 30, 1890, will be found in Appendix V V.

The estimate of funds required for this service for the fiscal year ending June 30, 1892, is given in the above-mentioned report as follows:

ESTIMATE OF APPROPRIATION REQUIRED FOR THE FISCAL YEAR ENDING JUNE 30, 1892, BY THE SUPERVISOR OF THE HARBOR OF NEW YORK.

For pay of inspectors, deputy inspectors, office force, and expenses of office	$20,000
For pay of crew and maintenance of steamer *Nimrod*	10,000
For pay of crew and maintenance of steamer *Argus*	10,000
For pay of crew and maintenance of steam-launch *Active*	3,000
For pay of crew and maintenance of steam-launch *Alert*	3,000
For purchase or construction of two steam-tugs	60,000
For pay of crew and maintenance of two steam-tugs to be purchased	20,000
Total	126,000

MISSISSIPPI RIVER COMMISSION.

This Commission, organized under the provisions of the act of Congress of June 28, 1879, reports to and receives instructions from the Secretary of War through this office.

The report of the Commission for the fiscal year ending June 30, 1890, embracing the following subjects, viz: (1), Surveys and examinations; (2), Construction; (3), Financial Statement; and (4), Estimates, will be found in Appendix W W.

The estimate of funds required for the service of the Commission for the fiscal year ending June 30, 1892, is stated in the above-mentioned report as follows:

ESTIMATE OF FUNDS FOR THE MISSISSIPPI RIVER COMMISSION FOR THE FISCAL YEAR ENDING JUNE 30, 1892.

For salaries, inspections, and traveling expenses of the Mississippi River Commission; for printing and telegraphing; for office expenses and miscellaneous	$35,000
For surveys and examinations of the Mississippi River from the Head of the Passes to its headwaters, continuing survey	150,000
For improving the Mississippi River from the Head of the Passes to the mouth of the Ohio River	4,000,000
For work at—	
Hickman, Ky	111,250
Greenville, Miss	350,000
Vicksburg, Miss	175,000
Natchez, Miss	250,000
New Orleans, La	200,000
Red and *Atchafalaya* rivers	350,000

MISSOURI RIVER COMMISSION.

This Commission, organized under the provisions of the act of July 5, 1884, reports to and receives instructions from the Secretary of War through this office.

The report of the Commission describing the operations in its charge for the fiscal year ending June 30, 1890, will be found in Appendix X X.

The estimate of funds required for the service of the Commission for the fiscal year ending June 30, 1892, is stated in the above-mentioned report as follows:

ESTIMATES FOR CONTINUING WORKS OF IMPROVEMENT FOR THE FISCAL YEAR ENDING JUNE 30, 1892.

Salaries of Commission, office and traveling expenses, surveys and observations, gauges, etc	$150,000
River above Sioux City*	175,000
River below Sioux City	1,100,000
Total	1,425,000

HARBOR LINES.

The river and harbor act of August 11, 1888, provides:

SEC. 12. Where it is made manifest to the Secretary of War that the establishment of harbor lines is essential to the preservation and protection of harbors, he may, and is hereby authorized to cause such lines to be established, beyond which no piers or wharves shall be extended or deposits made except under such regulations as may be prescribed from time to time by him.

In cases where it had been made manifest to the Secretary of War that the establishment of certain harbor lines is essential to the preservation and protection of the harbors, upon the recommendation of the Chief of Engineers, the cases were referred to Boards of Engineers for consideration and report. The boards having made the necessary examinations, rendered their reports with maps, which were submitted to the Secretary of War, by the Chief of Engineers, with recommendations that the lines as indicated be approved, and that the approval be placed upon the maps showing the harbor lines.

Under the requirements of the section above cited harbor lines have been established in the manner above described, as follows:

HARBOR LINES AT BOSTON HARBOR, MASSACHUSETTS.

The Board of Engineer Officers on Harbor Lines of the Port of Boston, consisting of Col. H. L. Abbot, Lieut. Cols. G. L. Gillespie, S. M. Mansfield, and Maj. W. R. Livermore, was constituted by paragraph 2, Special Orders, No. 11, Headquarters Corps of Engineers, January 30, 1889.

(*a*) *Dorchester Bay from South Boston to Moon Island, and left bank of Charles River Basin from Grand Junction Railroad Bridge to the navy-yard.*

Report dated January 28, 1890: submitted to the Secretary of War February 12, 1890: Approved February 13, 1890.

* The river and harbor act of September 19, 1890, having made an appropriation for the Missouri River above Sioux City, to be expended in the discretion of the Secretary of War, the improvement of *this part of the* river has been placed in charge of Capt. Charles F. *Powell, Corps of Engineers.*

(*b*) *Charles River, Massachusetts.*

Report dated March 7, 1890: submitted to the Secretary of War March 13, 1890: Approved March 17, 1890.

(*c*) *Mystic River with its tributaries and Chelsea Creek.*

Report dated May 23, 1890: submitted to the Secretary of War June 4, 1890: Approved June 20, 1890.

(*d*) *Extension of pier at Marine Park beyond established harbor lines, Dorchester Point, eastern end of South Boston.*

Report dated January 30, 1890: submitted to the Secretary of War February 3, 1890: Approved February 4, 1890.

(*e*) *Extension of solid filling beyond the established bulkhead lines at Simpson's Dry Dock No.* 1, *Boston Harbor.*

Report dated April 22, 1890: submitted to the Secretary of War April 24, 1890: Approved April 26, 1890.

(See Appendix B 21.)

HARBOR LINES OF STAMFORD HARBOR, CONNECTICUT.

The Board of Engineer Officers, consisting of Col. D. C. Houston, Lieut. Col. G. L. Gillespie, and Capt. Thos. L. Casey, constituted by paragraph 1, Special Orders, No. 78, Headquarters Corps of Engineers, November 30, 1889, made its report February 24, 1890. Report submitted to the Secretary of War February 27, 1890: Approved February 28, 1890.

(See Appendix D 24.)

HARBOR LINES IN THE HUDSON RIVER FROM TROY TO NEW-BALTIMORE, NEW YORK.

The Harbor Line Board for New York Harbor and adjacent waters (See Appendix E 14) made its report March 18, 1890. Report submitted to the Secretary of War March 22, 1890: Approved March 25, 1890.

(See Appendix E 13.)

HARBOR LINES FOR NEW YORK HARBOR AND ADJACENT WATERS.

The Board of Engineers for Harbor Lines in New York Harbor and adjacent waters, constituted by Special Orders, No. 11, Headquarters Corps of Engineers, January 30, 1889, consists of Cols. Henry L. Abbot, Wm. P. Craighill, C. B. Comstock, and Lieut.-Cols. D. C. Houston and G. L. Gillespie.

(*a*) *Kill von Kull and Shooter's Island.*

Report dated December 18, 1889: submitted to the Secretary of War December 27, 1889: Approved January 4, 1890.

(*b*) *East shore of East River, New York, from foot of Broadway, Brooklyn, to Ravenswood, Long Island.*

Report dated January 27, 1890: submitted to the Secretary of War February 7, 1890: Approved February 8, 1890. (See *l*, modification of pier-head line, approved June 18, 1890, page 333.)

(*c*) *Shore of New Jersey from Communipaw, Jersey City, to Constable Point, Bergen Neck.*

Report dated January 27, 1890: submitted to the Secretary of War January 30, 1890: Approved February 1, 1890.

(*d*) *South and west shores of Staten Island from Fort Wadsworth to Elizabethport, New Jersey, and west bank of Arthur Kill from Perth Amboy to Elizabethport, New Jersey.*

Report dated February 18, 1890: submitted to the Secretary of War March 1, 1890: Approved March 4, 1890.

(*e*) *East shore of East River, New York, Buttermilk Channel, and both shores of Gowanus Bay from Lawrence Point to Fort Hamilton.*

Report dated February 18, 1890: submitted to the Secretary of War March 3, 1890: Approved March 4, 1890.

(*f*) *West bank of Hudson River along Jersey City front from Weehawken Cove to Communipaw Ferry.*

Report dated February 18, 1890: submitted to the Secretary of War March 3, 1890: Approved March 4, 1890.

(*g*) *East, north, and west shores of Newark Bay, New Jersey.*

Report dated March 19, 1890: submitted to the Secretary of War March 26, 1890: Approved March 27, 1890.

(*h*) *West bank of North River from Weehawken Cove to Guttenberg, New Jersey; east bank of North River from West Eightieth street to the Battery, New York City; the Battery; and north and west shores of East River from the Battery to East Eighty-first street, New York City.*

Report dated April 15, 1890: submitted to the Secretary of War April 24, 1890: Approved April 25, 1890.

(*i*) *Raritan Bay and River, New Jersey, north shore from Perth Amboy to Crab Island, and south shore from Crab Island around South Amboy to Cheesequakes Creek.*

Report dated May 21, 1890: submitted to the Secretary of War June 18, 1890: Approved June 19, 1890.

(*j*) *Ellis Island, New Jersey.*

Report dated June 21, 1890: submitted to the Secretary of War July 8, 1890: Approved July 9, 1890.

(*k*) *Pier-head line for west half of south shore of Staten Island from Seguine's Point to Ward's Point.*

Report dated July 15, 1890: submitted to the Secretary of War July 25, 1890: Approved July 26, 1890.

(*l*) *Modification of pier-head line on east shore of East River from North First street, Brooklyn, to bridge across Bushwick Creek at Kent avenue.*

Report dated May 21, 1890: submitted to the Secretary of War June 5, 1890: Approved June 18, 1890.

(See Appendix E 14.)

HARBOR LINES IN THE JAMES RIVER, VIRGINIA, FROM RICHMOND TO CITY POINT.

The Board of Engineer Officers, constituted by Special Orders, No. 5, Headquarters Corps of Engineers, January 20, 1890, consisting of Col. Wm. P. Craighill, Lieut. Col. Peter C. Hains, and Lieut. G. J. Fiebeger, made its report March 17, 1890. Report submitted to the Secretary of War March 27, 1890: Approved March 28, 1890.

(See Appendix I 3.)

HARBOR LINES OF NORFOLK AND PORTSMOUTH HARBORS, VIRGINIA, AND THEIR ADJACENT WATERS.

The Board of Engineer Officers, constituted by paragraph 1, Special Orders, No. 13, Headquarters Corps of Engineers, February 4, 1889, consists of Col. Wm. P. Craighill, Lieut. Col. Peter C. Hains, and Lieut. G. J. Fiebeger.

(*a*) *Southern branch of Elizabeth River, and Elizabeth River* below Fort *Norfolk.*

Report dated January 20, 1890: submitted to the Secretary of War January 21, 1890: Approved January 23, 1890.

(*b*) *Eastern, southern, and western branches of Elizabeth River; Elizabeth River below western branch; and bulkhead lines in Norfolk Harbor from Norfolk and Western Railroad Bridge and United States Navy-Yard to Lambert's Point.*

Report dated April 30, 1890: submitted to the Secretary of War May 8, 1890: Approved May 9, 1890.

(See Appendix J 8.)

HARBOR LINES OF FERNANDINA HARBOR, FLORIDA.

The Board of Engineer Officers, constituted by Special Orders, No. 16, Headquarters Corps of Engineers, April 2, 1890, consisting of Col. Wm. P. Craighill, Maj. H. M. Adams, and Lieut. O. M. Carter, made its report April 25, 1890. Report submitted to the Secretary of War May 8, 1890: Approved May 9, 1890.

(See Appendix O 14.)

HARBOR LINES OF QUINCY BAY, ILLINOIS.

The Board of Engineer Officers, constituted by Special Orders, No. 4, Headquarters Corps of Engineers, January 12, 1889, consisting of Majs. A. Mackenzie, A. M. Miller, and E. H. Ruffner, made its report March 20, 1890. Report submitted to the Secretary of War March 27, 1890: Approved April 1, 1890.

(See Appendix Z 2.)

HARBOR LINES OF SAN FRANCISCO HARBOR AND ADJACENT WATERS.

The Board of Engineer Officers for the Harbor Lines of San Francisco Harbor and adjacent waters was constituted by paragraph 2, Special Orders, No. 51, Headquarters Corps of Engineers, October 11, 1888, and consists of Col. G. H. Mendell, Lieut. Col. W. H. H. Benyaurd, and Maj. W. H. Heuer.

(*a*) *Water front of the city of San Francisco and at Mission Rock, Bay of San Francisco.*

Report dated March 11, 1890: submitted to the Secretary of War March 22, 1890: Approved March 24, 1890.

(*b*) *Port Costa and Martinez on the south shore of Carquinez Strait, and Benicia on the north shore and east shore of Mare Island Strait along the fronts of North Vallejo, Vallejo, and South Vallejo, and front of Mare Island Navy-Yard on Mare Island Strait.*

Report dated July 22, 1890: submitted to the Secretary of War August 1, 1890: Approved August 2, 1890.

(See Appendix Q Q 4.)

HARBOR LINES IN FRONT OF SAN DIEGO AND CORONADO, CALIFORNIA.

The Harbor Line Board for San Francisco Harbor and adjacent waters was constituted a board for the harbor lines of San Diego Harbor and adjacent waters. Report dated March 14, 1890: submitted to the Secretary of War April 1, 1890: Approved April 2, 1890.

(See Appendix R R 5.)

BRIDGING NAVIGABLE WATERS OF THE UNITED STATES.

The plans and locations of the following bridges authorized by acts of Congress, having been found to comply with the requirements of said acts, have been approved by the Secretary of War, and copies sent to the officers of the Corps of Engineers in charge of the river and harbor districts in which the bridges are to be built, in order that they might supervise the construction so far as to see that the bridges are built in accordance therewith:

1. *Construction of draw in bridge operated by Philadelphia, Wilmington and Baltimore Railroad Company over Broad Creek, near Laurel, Delaware.*—Act approved June 6, 1888, directed the Secretary of War to serve notice to require the alteration of this bridge by the construction of a draw of sufficient size to admit of the passage of vessels. August 20, 1888, a draw of 40 feet span was approved by the Secretary of War.

Plan for the location of fenders in the draw submitted by the company February 11, 1889; approved by the Secretary of War August 2, 1889; copy sent to W. F. Smith, United States Agent, Major of Engineers, U. S. Army, Retired, August 7, 1889.

October 15, 1889, Major Smith reported the completion of the construction of the fenders in accordance with the approved plan.

2. *Bridge of the Louisville and Jeffersonville Bridge Company across the Ohio River between Louisville, Kentucky, and Jeffersonville, Indiana,* under acts "authorizing the construction of bridges over the Ohio River, and to prescribe the dimensions of the same," approved December 17, 1872, and an act supplementary to that act approved February 14, 1883.

The plans for the bridge in question, submitted April 30, 1888, were referred to a Board of Engineers in accordance with the requirements of the acts, which reported upon the same June 13, 1888, with recommendations—

1. That the proposed bridge be moved further up the river to some point at or above Wall street, in Jeffersonville, and that it be built with a channel span near the Indiana shore of 500 feet in the clear, and one near the island shore of 400 feet in the clear.

2. If the present location be accepted, the Board, while strongly disapproving of it, recommends that there be a span at least 650 feet wide in the clear near the Indiana shore, with the Indiana pier at low-water mark, and a span at least 400 feet in the clear near the island shore, with the Kentucky pier at low-water mark on the island.

The subject elicited much discussion, and finally, upon the presentation of a plan giving a span of 650 feet in the clear on the Indiana side, and a span of 400 feet in the clear on the Kentucky side, which was found to comply with the recommendations of the Board of Engineers, with the views of the Chief of Engineers, and also with the existing law regulating the height of bridges across the Ohio River, the plan was approved by the Secretary of War, February 28, 1889.

Copy sent to Maj. Amos Stickney, Corps of Engineers, March 12, 1889.

The reports in regard to this bridge were published in House Ex. Doc. No. 29, Fiftieth Congress, second session.

It having been alleged that the construction of the bridge according to the plans approved by the Secretary of War would be an obstruction to navigation, by direction of the Secretary of War a Board of Engineer Officers, consisting of Col. C. B. Comstock, Lieut. Col. Charles R. Suter, and Maj. Charles J. Allen, was appointed by Special Orders, No. 34, Headquarters Corps of Engineers, April 19, 1889, to report on the plans and location of the bridge. Their report, dated September 14, 1889, will be found in Appendix Y Y 5.

The company submitted, October 19, 1889, a modified plan providing for three spans of 550 feet each in the navigable part of the river instead of four spans, and having only two piers in the river at low water instead of three; this modification was approved by the Secretary of War October 19, 1889; and copy was sent to Maj. Amos Stickney, Corps of Engineers, November 1, 1889.

November 15, 1889, the company submitted a further modification of the plan, providing for six spans in all instead of seven, and increasing the length of the center channel span from 550 feet to 553 feet; this modification was approved by the Secretary of War November 15, 1889; and copy was sent to Maj. Amos Stickney, Corps of Engineers, November 18, 1889.

January 25, 1890, the company requested approval of the substitution of the low-water elevation of 1887 for that of 1889 on the plans; this modification was approved by the Secretary of War January 29, 1890; and copy was sent to Maj. Amos Stickney, Corps of Engineers, January 31, 1890.

3. *Bridge of the towns of North Hero and Grand Isle, Vermont, across channel in Lake Champlain between islands of North Hero and South Hero, Vermont.*—Act approved October 12, 1888.

Plans submitted by town of Grand Isle, Vt., March 27, 1889; approved by the Secretary of War July 2, 1889; copy sent Maj. M. B. Adams, Corps of Engineers, July 10, 1889.

4. *Bridge of the Muscatine Bridge Company across the Mississippi River at or near Muscatine, Iowa.*—Act approved July 16, 1888.

Plan and location submitted by the company June 4, 1889; approved by the Secretary of War, July 11, 1889; copy sent to Maj. A. Mackenzie, Corps of Engineers, August 2, 1889.

5. *Bridge of the Alabama Great Northwestern Railway Company, afterward Montgomery, Tuscaloosa and Memphis Railway Company, across the Alabama River, near Montgomery, Alabama.*—Act approved August 6, 1888.

Plan and location submitted by Montgomery, Tuscaloosa, and Memphis Railway Company, July 11, 1889; approved by the Secretary of War August 5, 1889; copy sent to Capt. P. M. Price, Corps of Engineers, August 20, 1889.

6. *Bridges of the commissioners of Muskingum County, Ohio, across the Muskingum River at Zanesville and near mouth of Brush Creek about 5 miles below Zanesville, Ohio.*—Act approved April 2, 1888.

Plans and location submitted by the commissioners May 7, 1889; approved by the Secretary of War August 5, 1889; copies sent to Lieut. L. H. Beach, Corps of Engineers, August 12, 1889.

7. *Bridge of the Tennessee Midland Railway Company across the Tennessee River at Perryville, Tennessee, between the counties of Decatur and Perry, Tenneseee.*—Act approved May 14, 1888.

Original plan and location submitted by the company March 27, 1889; revised plan and location submitted June 22, 1889; approved by the Secretary of War August 21, 1889; copy sent to Lieut. Col. J. W. Barlow, Corps of Engineers, August 27, 1889.

8. *Bridge of the city of La Crosse, Wisconsin, across the Mississippi River at La Crosse, Wisconsin.*—Act approved February 23, 1889.

Plan and location submitted by city of La Crosse August 26, 1889; approved by the Secretary of War September 30, 1889; copy sent to Maj. A. Mackenzie, Corps of Engineers, October 14, 1889.

9. *Bridge of the Wheeling Bridge Company across Ohio River at Wheel-*

ing, West Virginia.—General act approved December 17, 1872, and supplementary act approved February 14, 1883.

Plan and location submitted by the secretary of the company July 13, 1889; approved by the Secretary of War October 26, 1889; copy sent to Lieut. Col. Wm. E. Merrill, Corps of Engineers, November 13, 1889.

10. *Bridge of the Nashville and Knoxville Railroad Company across Caney Fork River, between Smith and Putnam counties, Tennessee.*—Act approved March 3, 1885, and amendatory act approved February 25, 1889.

Plan and location submitted July 26, 1889; approved by the Secretary of War December 12, 1889; copy sent to Lieut. Col. J. W. Barlow, Corps of Engineers, December 23, 1889.

May 30, 1890, Colonel Barlow reported that the bridge had been completed, with the exception that by reason of unequal settlement of the piers the draw would not turn, but that the company would immediately take steps to remedy the defect.

11. *Bridge of the New Orleans, Natchez and Fort Scott Railway Company across Tensas River, at or near Daniel's Ferry, Louisiana.*—Act approved March 1, 1889.

Plan and location submitted by the company, October 17, 1889; approved by the Secretary of War December 19, 1889; copy sent to Capt. J. H. Willard, Corps of Engineers, December 31, 1889.

12. *Bridge of the St. Louis, Keokuk, and Northwestern Railroad Company across the Missouri River at Bellefontaine Bluffs, below the city of St. Charles, Missouri.*—Act approved February 17, 1888.

Plan and location submitted by the company, November 7, 1889; approved by the Secretary of War December 21, 1889; copy sent to Lieut. Col. Chas. R. Suter, Corps of Engineers, December 28, 1889.

13. *Bridge of the West Virginia and Ironton Railroad Company across the Ohio River about 1½ miles above mouth of Big Sandy River, about 1 mile below Ceredo, West Virginia.*—General act approved December 17, 1872, and supplementary act approved February 14, 1883.

Plan and location submitted by the company, November 18, 1889; approved by the Secretary of War December 24, 1889; copy sent to Lieut. Col. Wm. E. Merrill, Corps of Engineers, January 2, 1890.

14. *Bridge of the Kansas City, Arkansas and New Orleans Railway Company across the Arkansas River at or near Cumming's Landing, Arkansas.*—Act approved July 24, 1888.

Plan and location submitted by the company January 4, 1890; approved by the Secretary of War February 25, 1890; copy sent to Capt. H. S. Taber, Corps of Engineers, March 4, 1890.

15. *Bridge of the Nebraska Central Railway Company across the Missouri River at Omaha, Nebraska.*—Act approved June 22, 1888.

Plan and location submitted by the company January 23, 1890; approved by the Secretary of War February 27, 1890; copy sent to Lieut. Col. Chas. R. Suter, Corps of Engineers, March 4, 1890.

16. *Bridge of the city of Nebraska City, Nebraska, across the Missouri River at or near Nebraska City, Nebraska.*—Act approved July 16, 1888.

Plan and location submitted by the mayor of the city February 10, 1890; approved by the Secretary of War April 3, 1890; copy sent to Lieut. Col. C. R. Suter, Corps of Engineers, April 7, 1890.

17. *Bridge of the Lyons and Fulton Bridge Company across the Mississippi River at or near Lyons, Iowa.*—Act approved March 2, 1889, amended by act approved March 15, 1890.

Plan and location submitted by the company February 24, 1890; and

revised plans submitted March 24, 1890; approved by the Secretary of War April 22, 1890; copy sent to Maj. A. Mackenzie, Corps of Engineers, April 26, 1890.

18. *Bridge of the Kansas and Arkansas Valley Railway Company across the Arkansas River in the Indian Territory at or near Fort Smith, Arkansas.*—Act approved March 15, 1890.

Plan and location submitted by the company in April, 1890; approved by the Acting Secretary of War May 17, 1890; copy sent to Capt. H. S. Taber, Corps of Engineers, May 21, 1890.

19. *Bridge of the city of Michigan City, Indiana, across Trail Creek in Michigan City, Indiana.*—Act approved June 29, 1888, amended by act approved April 22, 1890.

Plan and location submitted by the city May 13, 1890; approved by the Secretary of War June 4, 1890; copy sent to Maj. William Ludlow, Corps of Engineers, June 10, 1890.

20. *Bridge of the Pacific Short Line Bridge Company across the Missouri River at or near Sioux City, Iowa.*—Act approved March 2, 1889, amended by act approved April 30, 1890.

Plan and location submitted May 22, 1890, and revised plans submitted June 7, 1890; approved by the Assistant Secretary of War June 26, 1890; copy sent to Lieut. Col. C. R. Suter, Corps of Engineers, President of the Missouri River Commission, June 30, 1890.

BRIDGES OBSTRUCTING NAVIGATION.

The river and harbor act of August 11, 1888, provides as follows:

SEC. 9. That whenever the Secretary of War shall have good reason to believe that any railroad or other bridge now constructed, or which may hereafter be constructed, over any of the navigable water-ways of the United States is an obstruction to the free navigation of such waters, by reason of insufficient height, width of span, or otherwise, or where there is difficulty in passing the draw-opening or the raft span of such bridge by rafts, steam-boats, or other water-craft, it shall be the duty of the said Secretary to give notice to the persons or corporations owning or controlling such bridge to so alter the same as to render navigation through or under it free, easy, and unobstructed; and in giving such notice he shall prescribe in each case a reasonable time in which such alteration is to be made. If, at the end of such time, the alteration has not been made, the Secretary of War shall forthwith appraise [apprise] the Attorney-General of the United States, whose duty it shall be to institute suit, in the name of the United States, without delay, in the circuit or district court of the United States for the circuit in which such bridge is located, which court is hereby invested with jurisdiction for this purpose, to recover from the owners or managers of such bridge the fines mentioned in the succeeding sections of this act.

SEC. 10. That the owner or owners or manager or managers of any railroad or other bridge obstructing the free navigation of any navigable water-way of the United States who shall willfully fail or refuse to remove the same, or to cause the necessary alterations to be made in the same so as to render navigation through or under it free, easy, and unobstructed to rafts, steam-boats, or other water-craft, after receiving notice to that effect from the Secretary of War and within the time prescribed by him, shall be subject to a fine as penalty therefor of five hundred dollars per month for the time he or they are in default, and the amount so recovered shall be placed to the credit of the improvement fund of the water-way obstructed by such bridge.

In obedience to the above requirements, the Secretary of War notified the persons or corporations owning or controlling certain bridges to so alter the same as to render navigation through or under them free, easy, and unobstructed, and prescribed in each case a reasonable time when such alteration is to be made, as follows:

1. *Bridges across the Mississippi River.*—1. Notice dated November 8, 1888, was served upon the Hannibal Bridge Company November 17, 1888, and upon the Wabash Railway Company November 30, 1888, in reference to the bridge above Hannibal, Mo., owned by the bridge

company and controlled by the railway company, prescribing the 1st day of March, 1889, as the time when the required alteration is to be made and completed.

Upon representations made to the Secretary of War that it was desirable and reasonable to extend the time in which to perform the said work, he caused notices, dated March 18, 1889, to be served upon the Hannibal Bridge Company, the Wabash Railway Company, and the Missouri, Kansas, and Texas Railway Company, and notice dated April 17, 1889, to be served on the Missouri Pacific Railway Company, reciting in each of the notices the original notice of November 8, 1888, to the Hannibal Bridge Company and the Wabash Railway Company, and extending the time in which the alteration of the bridge shall be done to the 1st day of July, 1889.

The required alteration not having been made within the extended time, the Secretary of War duly apprised the Attorney-General.

In accordance with the recommendation of the Attorney-General new notices dated August 15, 1890, were served upon the Wabash Railway Company and the Missouri Pacific Railway Company, September 6, 1890, and upon the Hannibal Bridge Company September 23, 1890, extending the time to January 1, 1891.

2. Notice dated December 19, 1888, was served upon the Keokuk and Hamilton Bridge Company, in reference to the bridge at Keokuk, December 31, 1888, prescribing the 31st day of March, 1889, as the time when the required alteration is to be made and completed.

The required alteration not having been made within the prescribed time the Secretary of War duly apprised the Attorney-General, who instructed the United States attorney for the southern district of Iowa to institute suit.

2. *Bridges across the Tennessee River.*—1. Notice dated November 20, 1888, was served upon the East Tennessee, Virginia and Georgia Railway Company, operating the bridge over the Tennessee River at Florence, Ala., December 11, 1888, and notice dated January 11, 1889, was served upon the Memphis and Charleston Railroad Company January 19, 1889, prescribing the 1st day of June, 1889, as the time when the required alteration is to be made and completed.

The Memphis and Charleston Railroad Company, under date of March 2, 1889, submitted plans for the new draw-span proposed to be placed in the bridge, which were not recommended by the Chief of Engineers for approval, and the matter having been referred by the Secretary of War to the Acting Judge-Advocate-General, U. S. Army, was returned by him May 23, 1889, with report, of which the following is an extract:

> The time given by the Secretary of War in which to make the alteration will not expire until the 1st of June, 1889. He is not required or authorized by the act referred to to do anything in this matter at the present time. The act does not contemplate his approving or disapproving particular plans of alterations, but simply his giving to the bridge owners notices to alter their bridges so as to accomplish a certain purpose, and leaves it to them to make any alteration which will do this, or become liable to the penalty.
>
> It appears * * * that the officers of the Memphis and Charleston Railroad Company have been under the impression that it was necessary for them to submit plans of alterations for the approval of the Secretary of War, and * * * in consequence of this erroneous understanding much time has been lost, * * * and as the company does not appear to have acted in bad faith it seems right that the time be extended.

Acting upon this opinion of the Judge-Advocate-General, the Secretary of War, upon the recommendation of the Chief of Engineers, dated June 1, extended the time for completing the alteration to December 1, 1889.

The officer in charge of the district in which this bridge is locate reports, under date of August 11, 1890:

The general manager of the East Tennessee, Virginia and Georgia Railway, ope ating said bridge, writes me under date of July 25, that "our contractors hope to g the Florence draw up early in September" (1890).

2. Notice dated July 12, 1889, was served upon the president of tl Nashville, Chattanooga and St. Louis Railway Company July 15, 188 in regard to the railroad bridge across the Tennessee River at Johnso ville, Tenn., prescribing the 1st day of August, 1892, as the time whe the required alteration is to be made and completed.

3. *Bridges across the Charles River, Massachusetts.*—Notice dated N vember 21, 1888, was served upon the Fitchburg Railroad Compan December 1, 1888, in reference to the bridge controlled by that compan across the Charles River, within the limits of the city of Boston.

Notices dated December 6, 1888, were served as follows:

December 15, 1888, on the Boston and Maine Railroad Company, i reference to the bridge built by that company across the Charles Riv and the bridge erected by the Eastern Railroad Company and controlle by the Boston and Maine Railroad Company, both of them within tl limits of the city of Boston, and also in reference to the two bridg erected by the Boston and Lowell Railroad Company and controlled b the Boston and Maine Railroad Company across the Charles Riv between the cities of Boston and Cambridge, obstructing the navigatio of the Charles River.

December 15, 1888, on the city of Boston in reference to bridges acro Charles River, known as Charles River Bridge and Warren Bridg within the limits of the city of Boston.

December 17, 1888, on the commissioners on West Boston, Canal, an Prison Point bridges controlled by them, in reference to the bridg across the Charles River, known as West Boston Bridge and Canal c Craigies Bridge.

In all these cases the 1st day of January, 1891, was prescribed as th time when the required alterations are to be made and completed.

Upon the request of the corporation counsel of the city of Boston, an of the city solicitor of the city of Cambridge, a Board of Engineer Off cers consisting of Col. H. L. Abbot, Lieut. Col. George L. Gillespie, an Lieut. Col. S. M. Mansfield, was appointed by Special Orders, No. 8 Headquarters Corps of Engineers, December 14, 1889, to consider th bridges across the Charles River owned and controlled by the cities c Boston and Cambridge. February 1, 1890, the Board submitted the report in which they recommended that the time be extended indef nitely; the recommendation was approved by the War Department Fel ruary 27, 1890.

(See Appendix Y Y 6.)

4. *Bridge across the Taunton River at Somerset, Massachusetts.*—Notic dated November 28, 1888, was served upon the President of the Ol Colony Railroad Company, December 15, 1888, prescribing the 1st da of May, 1889, as the time when the required alteration is to be mad and completed.

The required alteration not having been made within the prescribe time, the Secretary of War duly apprised the Attorney-General, wh intrusted the case to the United States attorney for the district c Massachusetts with instructions to institute suit as provided.

5. *Bridge across the St. Joseph River, Michigan, near its mouth.*—Notic dated December 4, 1888, was served upon the president of the Chicag

and West Michigan Railway Company, December 12, 1888, designating April 30, 1889, as the time when the required alteration is to be made and completed. A request was made by the company, April 20, 1889, that the changes they were making in the draw be put to the test of trial, which was deemed to be a reasonable one, and upon recommendation of the Chief of Engineers, dated May 6, 1889, "that no further notice be given the company at present, it being distinctly understood that such delay is not to be construed as an approval of the structure as it now exists," the recommendation was approved by the Secretary of War, May 17, 1889.

The report of the engineer officer in charge of the district in which the bridge is located, dated August 21, 1890, showing a continuance of obstructions subsequent to alteration of the draw, and still existing at the date of the report, a new notice, dated September 12, 1890, was served upon the secretary of the railway company September 18, 1890, prescribing the 1st day of March, 1891, as a reasonable time when the required alteration is to be made and completed.

6. *Bridges across Muskingum River, Ohio.*—1. Notice dated December 8, 1888, was served upon the commissioners of Washington County, Ohio, December 20, 1888, in reference to the bridge between the towns of Beverly and Waterford, prescribing the 30th day of September, 1889, as the time when the required alteration is to be made and completed.

Upon the request of the authorities of Washington County the time was subsequently extended to March 31, 1890, and again to September 30, 1890.

2. Notice dated March 18, 1889, was served upon the commissioners of Muskingum County, Ohio, owning or controlling the canal of the Muskingum River navigation at Zanesville, April 4, 1889, in reference to bridge over the canal at that place.

3. Notice dated March 18, 1889, was served upon the commissioners of Muskingum County, Ohio, owning or controlling the bridge across the Muskingum River at the head of Fifth street, Zanesville, Ohio, known as the Fifth Street Bridge, April 4, 1889.

4. Notice dated March 20, 1889, was served upon the commissioners of Washington County, Ohio, owning or controlling the Lowell Canal, April 5, 1889, in reference to the bridge across the canal.

In all these cases the 1st day of November, 1889, was prescribed as the time when the required alterations are to be made and completed.

Upon the request of the commissioners of Muskingum County and of Washington County, the time was subsequently extended to the 1st day of November, 1890.

5. Notice dated January 3, 1890, was served upon the commissioners of Washington County, Ohio, January 13, 1890, in reference to the bridge across the upper end of the Lowell Canal, prescribing December 31, 1890, as the time when the required alteration is to be made and completed.

7. *Bridges across the White River, Indiana.*—1. Notice dated December 19, 1888, was served upon the Evansville and Indianapolis Railroad Company, operating railroad bridge at Rogers, Ind., on White River, one-half mile above its forks, January 7, 1889, prescribing the 1st day of January, 1890, as the time when the required alteration is to be made and completed.

2. Notice dated December 19, 1888, was served upon the Evansville and Terre Haute Railroad Company, operating railroad bridge at or near Hazleton, Ind., January 7, 1889, prescribing the 1st day of Jan-

uary, 1890, as the time when the required alteration is to be made and completed.

The required alterations not having been made within the prescribed time, the Secretary of War duly apprised the Attorney-General who intrusted the cases to the United States attorney for the district of Indiana, with instructions to institute suit as provided.

Upon explanation of the cause of delay by the railroad companies and their request for a further extension, which was considered reasonable, an extension was granted to July 1, 1890, and the Attorney-General advised. The time was subsequently extended to January 1, 1891, on condition that the river be dredged so that the channel at the lower bridge (Hazleton) will pass immediately under the draw and that the extension will not withdraw the order relative to the upper bridge (at Rogers).

8. *Bridge across the St. Louis River from Grassy Point, Minnesota.*—Notice dated January 2, 1889, was served upon the St. Paul and Duluth Railway Company, January 21, 1889, prescribing the 1st day of September, 1889, as the time when the required alteration is to be made and completed.

The required alteration not having been made within the prescribed time the Secretary of War duly apprised the Attorney-General.

9. *Bridges across the Kentucky River.*—Notices dated January 2, 1889, were served, as follows:

1. January 10, 1889, upon the Louisville and Nashville Railroad Company, in regard to the railroad bridge across the Kentucky River at Frankfort, Ky.

2. January 10, 1889, upon the Louisville and Nashville Railroad Company, operating and controlling the railroad bridge at Worthville, Ky.

3. January 23, 1889, upon the mayor of the city of Frankfort, Ky., in regard to the bridge at foot of St. Clair street, in that city.

In all of these cases the 1st day of January, 1890, was prescribed as the time when the required alterations are to be made and completed.

Subsequently, upon the application of the Louisville and Nashville Railroad Company, and upon the applications of the authorities of Franklin County and of the city of Frankfort, the time was extended to January 9, 1891.

10. *Bridge across or near the mouth of Moodna or Murderer's Creek, in Cornwall, Orange County, in the State of New York.*—Notice dated January 28, 1889, was served upon the New York Central and Hudson River Railroad Company, lessee of the West Shore Railroad, *via* west shore of the Hudson River, February 7, 1889, prescribing the 1st day of July, 1889, as the time when the required alteration is to be made and completed.

The alteration not having been made within the prescribed time, the Secretary of War duly apprised the Attorney-General, who instructed the United States attorney for the southern district of New York to institute suit.

11. *Bridge across the St. Francis River, Arkansas.*—Notice dated February 16, 1889, was served upon the St. Louis, Arkansas and Texas Railway Company, in reference to the bridge at St. Francis, Ark., February 23, 1889, prescribing the 1st day of September, 1889, as the time when the required alteration is to be made and completed.

The required alteration not having been made within the prescribed time, the Secretary of War duly apprised the Attorney-General, who instructed the United States attorney for the eastern district of Missouri to institute suit.

12. *Bridges across the Ocmulgee River, Georgia.*—1. Notice dated April 12, 1889, was served upon the East Tennessee, Virginia and Georgia Railway Company, April 24, 1889, in regard to the bridge near Lumber City, Ga., prescribing the 1st day of August, 1889, as the time when the required alteration is to be made and completed. The time was subsequently extended to December 1, 1889.

A new bridge to replace the old one is in process of construction.

2. Notice dated January 21, 1890, was served upon the president of the Covington and Macon Railroad Company, February 8, 1890, in regard to the bridge 1 mile below Macon, Ga., prescribing July 1, 1890, as the time when the required alteration is to be made and completed. Upon application of the railroad company the time was subsequently extended to November 1, 1890.

3. Notice dated January 21, 1890, was served upon the East Tennessee, Virginia and Georgia Railway Company, in regard to the bridge 6 miles below Macon, Ga., prescribing July 1, 1890, as the time when the required alteration is to be made and completed.

The required alteration has not yet been made, but a contract has been let for the work.

4. Notice dated January 21, 1890, was served upon the president of the East Tennessee, Virginia and Georgia Railway Company, February 3, 1890, in regard to the bridge at Hawkinsville, Ga., prescribing July 1, 1890, as the time when the required alteration is to be made and completed.

The required alteration has not yet been made, but a contract has been let for the work.

5. Notice dated January 21, 1890, was served upon the commissioners of Pulaski County, February 8, 1890, in regard to the highway bridge at Hawkinsville, Ga., prescribing July 1, 1890, as the time when the required alteration is to be made and completed.

The time for completing the alteration was subsequently extended for one year, but revoked, and a new notice, dated September 1, 1890, was issued* prescribing January 1, 1891, as the time when the required alteration is to be made and completed.

13. *Bridges across Lumber River, North Carolina*, as follows: At Fair Bluff, at Princess Ann, at Ivey Bluff, at Phillips', and at Matthews' Bluff, owned jointly by the counties of Robeson and Columbus, in the State of North Carolina.

Notices dated April 19, 1889, were served upon the boards of commissioners of Columbus and Robeson counties, North Carolina, May 7, 1889, prescribing November 7, 1889, as the time when the required alterations are to be made and completed.

Upon application of the commissioners of Columbus County, the time was subsequently extended to June 30, 1890. Alteration to bridge at Fair Bluff has been made, and work on the four other bridges is in progress.

14. *Bridge across the channel leading to Back Cove, Portland, Maine.*—Notice dated August 31, 1889, was served upon the agent of the Grand Trunk Railway Company of Canada, at Portland, Me., September 14, 1889, prescribing June 30, 1890, as the time when the required alteration is to be made and completed.

The required alteration not having been made within the prescribed time, the Secretary of War duly apprised the Attorney-General, who instructed the United States attorney for the district of Maine to institute suit.

15. *Bridge across Missisquoy Bay.*—Notice dated September 18, 1889,

*Served November 1, 1890.

was served upon the president of the Central Vermont Railroad Company, October 2, 1889, prescribing the 1st day of May, 1890, as the time when the required alteration is to be made and completed. Upon application of the railroad company the time was extended to July 1, 1890, and subsequently to September 1, 1890.

The required alteration not having been made within the time prescribed by the last extension, the Secretary of War duly apprised the Attorney-General.

16. *Bridge across the Oconee River.*—Notice dated April 3, 1890, was served upon the Savannah, Americus and Montgomery Railway Company, April 17, 1890, in reference to their bridge near Mount Vernon, Ga., prescribing December 31, 1890, as the time when the required alteration is to be made and completed.

17. *Bridges across the Harlem River, New York City.*—Notices dated July 2, 1890, were served as follows:

July 9, 1890, upon the mayor of the city of New York, in reference to the bridge owned by the city, across the river at Third avenue; and

July 8, 1890, upon the vice-president of the New York Central and Hudson River Railroad Company, and of the New York and Harlem Railroad Company, in reference to the railroad bridge across the river at Fourth avenue.

In the cases of both of the bridges January 2, 1892, was designated as a reasonable time when the required alterations are to be made and completed.

A Board of Engineer Officers, consisting of Col. Henry L. Abbot, Col. C. B. Comstock, and Lieut. Col. G. L. Gillespie, was appointed by Special Orders No. 25, Headquarters Corps of Engineers, dated May 7, 1890, to investigate and report upon the alleged obstruction of navigation by certain bridges over the Harlem River, New York.

The report of the Board, dated June 19, 1890, will be found in Appendix Y Y 7.

The river and harbor act approved September 19, 1890, makes the following provision for replacing these bridges:

Improving Harlem River, New York: Continuing improvement, two hundred and fifty thousand dollars; and the Secretary of War is directed to cause the low bridges now crossing said Harlem River to be replaced by other bridges at the expense of the owners thereof as soon as the necessary legislation, if any such legislation be necessary, shall have enabled the change in grade to the approaches of said bridges, thus required, to be made, the owners of said bridges being allowed a reasonable time in which to complete the work necessary for said approaches. Said bridges shall leave a clear space, between the under sides thereof and the high water of spring tides, of twenty-four feet, and shall be provided with draw-spans and draws of the width and length to be determined by the Secretary of War, and shall in all respects comply with this law and conform to the requirements of the Secretary of War: *Provided*, That the Secretary of War shall prescribe the times and regulations for the opening and operating of the draws in said bridges, but said draws shall not be opened except for vessels propelled by steam with or without vessels in tow; nor shall they be required to be opened at any times other than between ten o'clock in the forenoon and five o'clock in the afternoon.

OCCUPANCY OF AND INJURY TO PUBLIC WORKS BY CORPORATIONS AND INDIVIDUALS.

Under the requirements of section 2 of the river and harbor act approved July 5, 1884, and section 4 of the river and harbor act approved August 5, 1886, there are submitted herewith reports of officers in charge of river and harbor districts of instances, in which piers, breakwaters, or other works built by the United States in aid of commerce or navigation, are used, occupied, or injured by corporations or individuals.

(*See Appendix Z Z.*)

MISCELLANEOUS.

[Public works not provided for in acts making appropriations for the construction, repair, and preservation of works on rivers and harbors.]

MAINTENANCE AND REPAIR OF WASHINGTON AQUEDUCT—WATER SUPPLY, DISTRICT OF COLUMBIA—INCREASING THE WATER SUPPLY OF WASHINGTON, D. C., ACT MARCH 2, 1889—ERECTION OF FISH-WAYS AT THE GREAT FALLS OF THE POTOMAC.

Officers in charge, Lieut. Col. John M. Wilson, Corps of Engineers, Colonel U. S. Army, until July 17, 1889, and since that date Lieut. Col. George H. Elliot, Corps of Engineers; Capt. C. McD. Townsend, Corps of Engineers, assistant to the officer in charge until June 28, 1890.

1. *Washington Aqueduct.*—During the past year the usual operations for maintaining and preserving the aqueduct have been carried on. The mains have been flushed; the valves oiled and cleaned; the gate-keepers' houses have been repaired; the gates adjusted so as to preserve the water in the distributing reservoir at as high a level as possible; the dams and embankments, wherever they have been washed or cut by rains, have been repaired; the ditches and culverts along the line of the conduit, on which the safety of the conduit depends, have been kept in order, and about 4,234 running feet of ditches have been paved.

The oak flooring of the Pennsylvania Avenue Aqueduct Bridge over Rock Creek was renewed; the fences on the southerly and westerly sides of the distributing reservoir were completed by building about 1,200 feet of fence; the 7-foot conduit around the distributing reservoir, one-half mile long, was cleaned of its sediment, and opportunity was taken of the emptying of the 36-inch main, while making connections with the new 48-inch main, to replace some important blow-offs in the former main. Every opportunity that the river would allow has been utilized in the work of replacing the heavy coping of the dam at Great Falls, which was carried away by the great freshet of June, 1889, but it has been greatly retarded by the frequent rains of the last year, that have kept the depth of water flowing over the dam much greater than in its usual low-water stages. The entire length of the break, 347 feet, in the coping of the dam across the Maryland channel was replaced during the months of July and August. During the months of September and October a length of 442 feet of the coping of the dam across the Virginia channel was replaced. Operations were then suspended for the season by reason of high water. In the Virginia dam there remains the most difficult part of the work, a length of 314 feet, which is now in progress, and every effort will be made to complete it during the low water of this summer, if the river will permit. At the distributing reservoir, while connecting the new 48-inch main with the reservoir, it became necessary to drain the lower division, so that this reservoir was cut out of the system of supply from the middle of October, 1889, to the 18th of March, 1890, and the water passed around the reservoir in the 7-foot conduit.

During this period the water from Great Falls was supplied directly to the mains without passing through either resrvoir. Advantage was taken of the emptying of this reservoir, which had not been done before in about twenty years, to make a number of repairs that had been postponed, some of them a long time, for some such opportune occasion. Valves were put in good condition, the old screen which had been out of order for a number of years, *was removed*, the bottom of the screen-

house was thoroughly cleaned out, the frame work for a new screen was erected and a contract was made for the latter. The lower division of the reservoir was partially cleaned, but the cleaning out of the twenty years' deposit of clayey sediment in the upper, the settling, division could not be done for want of funds.

Before replacing on the lines of the public land the fences that were removed for the purpose of laying the 48-inch main, these lines were re-established by the official surveyor of the District of Columbia and were marked by permanent stone monuments.

There was but one serious break in the mains during the year. While the work of connecting the new 48-inch main with the reservoir was in progress a large leak which was found to proceed from a broken section of the 36-inch main under the dam of the reservoir was discovered, but it was thoroughly repaired before any serious damage was done.

Attention is invited to the recommendations of the officer in charge respecting the works required for improving the quality of the Washington water supply and for the protection of the aqueduct, also the necessity of a storage yard near the aqueduct office for the storage of the spare sections of the various mains and the other articles required for repairs in case of breaks in the mains.

July 1, 1889, amount available		$20,000.00
July 1, 1890, amount expended during fiscal year	$16,916.74	
July 1, 1890, outstanding liabilities	2,840.54	
July 1, 1890, amount covered by uncompleted contracts made during the fiscal year ending June 30, 1890	238.60	
		19,995.88
July 1, 1890, amount to be covered into the United States Treasury		4.12

The estimates of the officer in charge for the fiscal year ending June 30, 1892, are as follows:

For improving the receiving reservoir, including the purchase or condemnation of the necessary land	$284,625.00
For improving the distributing reservoir by lowering the height of the cross dam	12,500.00
For protecting the inlet to the aqueduct at Great Falls	5,000.00
For extending the outlet of waste weir No. 3	2,500.00
For purchase or condemnation of a site for a storage yard	7,500.00
For cleaning out the distributing reservoir	13,825.00
For maintenance and repairs of the aqueduct and the reservoirs, roads, etc., connected therewith	21,000.00
	346,950.00

(See Appendix A A A 1.)

2. *Water supply, District of Columbia; the 48-inch main.*—By the act of Congress, approved March 2, 1889, $575,000 was appropriated—

to enable the Secretary of War to cause to be constructed and put in operation a forty-eight-inch cast-iron main from the present distributing reservoir above Georgetown easterly to Rock Creek at M street, and thence along M street to New Hampshire avenue; thence northeasterly along New Hampshire avenue to R street north; thence along R street to connect with the present forty-eight-inch main from the new reservoir at R and Fourth streets, and to make the necessary connections and to provide the necessary apparatus for thereby specially supplying the present deficiencies of water at the higher levels of the city, and in general to increase the water supply. The said work shall be done under the direction of the Chief of Engineers, in the shortest practicable time.

Under the authority contained in the latter portion of the act, it was decided to do the following work, in addition to the laying of the 48-inch main: To lay a 30-inch main on Capitol Hill extending from the *old 30-inch main* at New Jersey avenue and B street across the Capitol

grounds, and thence on East Capitol street to Eleventh street east; to construct the by-passes on New Jersey avenue, and to place the valves in the 36-inch main and in its outlets northward along the line of L street, required for the purpose of dividing the city into high and low service areas; to make the connections required to enable the 36-inch and 30-inch mains to be re-inforced by the 48-inch main, and to re-inforce each other, as required for the best supply of the high and low service areas, and in addition to its connection with the distributing reservoir, to connect the 48-inch main with the auxiliary gate-house, the terminus of the 7-foot conduit around the distributing reservoir.

Contracts having been made for the major portion of the material required, for hauling it, and for the excavation of the trenches, the early part of the fiscal year was occupied in preparations for laying the mains by the constructing of derricks, the purchase and fabrication of tools and implements, and the engagement of foremen for the different gangs of workmen required. On the 12th of August the first working force had been organized and the work of laying commenced at the eastern terminus of the 48-inch main on R street. Other parties were soon after at work on the Conduit road, at the distributing reservoir in excavating through the dam for the connection of the 48-inch main with the reservoir, on M street in Georgetown, on Capitol Hill, and on the Canal road. The water of the reservoir was turned into and flowed through the new mains, which were finished, the 30-inch main in January and the 48-inch main in March, on the 20th of the latter month. The result of the work may be summarized as follows: The water on Capitol Hill, except where its free flow is obstructed by defects in the city's distribution system, stands about 30 feet higher than before the completion of the 48-inch main; the water in the high part of northwest Washington has a corresponding increase in elevation, and the city is relieved of the expense of pumping water for the supply of the latter section of the city.

Since the new mains were sufficiently completed to allow the water to be turned into them, a large amount of work that remained has been done in making connection between the 48-inch main and the old mains and between the old mains themselves; in making connections with the city's street mains; in placing the 36-inch main and its outlets northward, the valves, and across the route of the old 30-inch main on New Jersey avenue, the by-passes required; in constructing the masonry chambers required for the large valves along the routes of the mains; in the completion of the chamber for the new valves at the reservoir and in replacing the dam where connection was made with it; in replacing pavements, and other works not necessary to enumerate.

In providing for doubling the delivery to the street mains of the city's distribution system by the laying of the 48-inch main, the United States has furnished an abundant supply for all the uses of the Government and of citizens, with a large allowance for wastage, for many years to come, and if there is in any portion of the city any lack of water or of pressure it is due to defects either in the street mains or in the service-pipes connecting these mains with houses.

In the high area in the vicinity of M, N, and O streets, between Tenth and Thirteenth streets, there is still so much loss of head by reason of the small size and bad condition of the street mains that the engineer in charge has recently been authorized to use a portion of the remainder of the appropriation in laying in Eleventh street a 24-inch main from U street to K street, connecting at U street with the city's 12-inch main, at R street with the 48-inch main, at L street with the 36-inch main,

and at K street with the 30-inch main, but the connection between the 48-inch main and the latter two mains is to be kept closed except in case of fire or of other urgent necessity. For similar reasons and looking to the future of Capitol Hill, he has also been authorized to lay a 30-inch main on New Jersey avenue between L and B streets. This main will be laid parallel to the old 30-inch main in New Jersey avenue and will connect at L street with the 48-inch main and at B street with the new 30-inch main on Capitol Hill.

July 1, 1889, amount available		$303,158.78
July 1, 1890, amount expended during fiscal year, exclusive of liabilites outstanding July 1, 1889	$177,771.13	
July 1, 1890, outstanding liabilities	3,995.05	
July 1, 1890, amount covered by uncompleted contracts made during the fiscal year ending June 30, 1890	1,081.90	
		182,848.08
July 1, 1890, balance available		120,310.70

No estimate for further appropriation is submitted.

(See Appendix A A A 2.)

3. *Increasing the water supply of Washington, D. C.*—This work was commenced under an appropriation made in the act of Congress approved July 15, 1882.

The plan consisted of raising the dam in the Maryland channel at the Great Falls of the Potomac to an elevation of 148 feet above mean tide at the Washington navy-yard, and its extension at that height across Conn's Island and the Virginia channel of the river; extending the Washington Aqueduct from the distributing reservoir above Georgetown to the site selected for the new reservoir near Howard University by a tunnel 20,696.3 feet long; constructing at the tunnel outlet a new reservoir of about 300,000,000 gallons capacity, and connecting this reservoir by a new line of large mains with the existing system of water-mains in the city of Washington.

All operations on this project are suspended, and no work has been done during the year.

In July an assistant engineer was employed in preparing maps, cross-sections, etc., of the new reservoir and determining quantities excavated, to comply with a request of the Court of Claims for data in connection with the claim of the contractors against the United States.

In January two men were employed in excavating for measuring the outflow of water from the tunnel at Rock Creek.

A watchman has been employed during the year at the new reservoir.

July 1, 1889, amount unexpended on all items of appropriation	$437,128.91
July 1, 1890, amount expended during fiscal year	520.37
July 1, 1890, balance available	436,608.54

No estimate for further appropriation is submitted.

(See Appendix A A A 3.)

4. *Erection of fish-ways at Great Falls.*—Plans and specifications for a new system of fish-ways are being prepared under the supervision of the Commissioner of Fish and Fisheries.

By direction of the Secretary of War the construction will be carried on under the direction of the Commissioner above mentioned, the engineer in charge being held responsible only for the proper protection of the dam at the Great Falls and for the disbursement of the funds appropriated.

No work has been in progress upon the fish-ways during the year.

The only expenditure was for a draughtsman employed in the office of the Commissioner of Fish and Fisheries in July, 1889, for four days.

July 1, 1889, amount available	$30,044.32
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	24.00
July 1, 1890, balance available	30,020.32

No estimate for further appropriation is submitted.

(See Appendix A A A 4.)

IMPROVEMENT AND CARE OF PUBLIC BUILDINGS AND GROUNDS, AND CARE AND MAINTENANCE OF THE WASHINGTON MONUMENT, IN THE DISTRICT OF COLUMBIA.

Officer in charge, Col. John M. Wilson, U. S. Army, Lieutenant-Colonel, Corps of Engineers, from July 1, 1889, to September 7, 1889; since that date, Col. O. H. Ernst, U. S. Army, Major, Corps of Engineers.

All the necessary care for maintaining them in good condition was bestowed upon the various improved parks, and three of the smaller reservations not hitherto improved were partially improved, as follows:

Reservation No. 101, at the intersection of Maryland and Virginia avenues, between Seventh and Ninth streets, southwest; that portion of the ground lying north of the railway tracks was graded and inclosed with an iron post-and-chain fence.

Reservation No. 158, at the intersection of New York avenue, First and M streets, northwest, consisting of an irregular mound standing some 7 feet above the regular grades, was cut down to a level with the surrounding street surfaces.

Reservation No. 207, at the intersection of North Carolina avenue, Ninth and A streets, southeast, was inclosed with an iron post-and-chain fence.

In the grounds north of the Executive Mansion the asphalt walks were renewed, and in the Smithsonian Grounds 1,759 square yards of additional asphalt pavement and 445 square yards of additional asphalt foot-walks were constructed, and an asphalt pavement covering an area of 690 square yards was laid between the center building and wings of the Army Medical Museum.

The work of improving the grounds around the Pension Building in Judiciary Square has been well advanced, and in Reservation No. 17 (Garfield Park) additional ground has been graded for lawn surfaces, and new gutters and drain-traps constructed and drain-pipes laid.

The Washington Monument received the necessary care, and the improvement of the grounds around its base was continued as far as available funds would permit. There were 175,174 visitors to the top of the Monument during the year, making a total of 297,145 persons who have made the ascent since the shaft was opened to the public in October, 1888.

An additional greenhouse structure was erected in the nursery grounds, and a large fountain-basin with an ornamental stone coping was constructed in the reservation at the intersection of Pennsylvania avenue and Thirteenth street, northwest.

A foundation was constructed in Lafayette Square and a granite base and platform set in place thereon, in readiness to receive the pedestal for the statue of General Lafayette and his compatriots.

A portion of the 4-inch pipe conveying water from the Franklin

Square spring to the Executive Mansion was taken up and replaced with new pipe, and additional water-pipe was also laid in the nursery grounds.

Necessary carpentry, painting, plumbing, and gas-fitting repairs were made in the Executive Mansion, and some new carpet, matting, and articles of furniture purchased. An electric fire-alarm system was introduced and facilities provided for extinguishing fires.

Attention is invited to the detailed report of the officer in charge and to his estimates for the ensuing fiscal year, as follows:

For improvement and care of public buildings and grounds		$186,037.20
For compensation of persons employed on public buildings and grounds.		54,280.00
For replacing the overhead system of telegraph wires with duplicate six-conductor underground cable, and for care and repair of existing lines.		19,965.00
For contingent and incidental expenses of public buildings and grounds.		500.00
For care of Washington Monument and maintenance of elevator:		
Salaries of employés	$9,060.00	
Fuel, light, contingencies, etc	3,600.00	
		12,660.00
		273,442.20

(See Appendix B B B.)

SURVEY OF ROAD FROM THE AQUEDUCT BRIDGE TO MOUNT VERNON, VIRGINIA.

Lieut. Col. Peter C. Hains, Corps of Engineers, in charge.

Congress, by act approved February 23, 1889, authorized the Secretary of War to cause surveys to be made for a national road from a point at or near the Virginia end of the Aqueduct Bridge to Mount Vernon, a report on the same to be made to Congress, together with an estimate of the cost of building such a road. Ten thousand dollars was appropriated to defray the expenses of the survey.

The work was assigned to the charge of Lieutenant-Colonel Hains in March, 1889. The field work of the survey was commenced in May, 1889, and was completed about the middle of September of the same year, when the office work was commenced. The latter was completed during January of 1890. Three principal routes were surveyed, as well as a number of connecting lines, so that other routes can be made by combining parts of the principal ones. Under date of January 4, 1890, Lieutenant-Colonel Hains submitted a detailed report of the survey, a copy of which is appended to his annual report.

July 1, 1889, amount available	$7,473.46
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	5,360.75
July 1, 1890, balance	2,112.71
Total cost of survey	7,887.29

(See Appendix C C C.)

SURVEY OF THE NORTHERN AND NORTHWESTERN LAKES.

Survey and location of danger reef near mouth of Gooseberry River, north shore of Lake Superior.—This dangerous reef was located and plotted in October, 1889, under the direction of Maj. James B. Quinn, Corps of Engineers, the officer in charge. It lies about one-half mile from shore, is of small area, and has but 12½ feet of water over it at the *shoalest place.* There is deep water all around it. It is a dangerous

obstruction to vessels coasting the north shore of the lake, or to those which may be befogged and out of their course.

The sum of $200 was allotted for this work, and the survey connected with its location cost $178.79, leaving a balance on hand of $21.21.

(See Appendix D D D 1.)

WATER-LEVEL OBSERVATIONS FOR LAKE ERIE.

The officer in charge, Maj. L. Cooper Overman, Corps of Engineers, submits a report on the following:

Tri-daily observations at Erie and Cleveland; elevation of the zero of the guages at Erie and Cleveland above the plane of reference; elevation of the "check point" at Erie above plane of reference; also a special report on gauges and reference points pertaining to water-levels in his district.

(See Appendix D D D 2.)

PRINTING AND DISTRIBUTION OF CHARTS OF THE NORTHERN AND NORTHWESTERN LAKES.

Under the supervision of this office additions have been made to the engraved copper-plates of charts of—

Lake Superior Nos. 2 and 3;
Eagle Harbor, Lake Superior;
Straits of Mackinac;
North end of Lake Michigan;
South end of Lake Michigan;
North end of Green Bay;
South end of Green Bay;
Lake Michigan coast charts Nos. 1, 2, 3, 4, 5, 6, 7, and 9;
Lake Huron;
Lake St. Clair;
Detroit River;
Lake Erie;
Lake Erie coast charts Nos. 5, 6 and 7;
Sandusky Bay;
Lake Ontario;
Lake Ontario coast charts Nos. 3 and 4;
St. Lawrence River No. 4.
A chart of Erie Harbor has also been engraved and a limited number printed.

During the year 7,460 charts were issued under the supervision of Col. O. M. Poe, Corps of Engineers, 4,182 of which were sold at 30 cents each, and the amount, $1,254.60, turned into the Treasury.

Owing to changes in channels, the discovery of previously unknown dangers, and the extension of works of river and harbor improvement, a number of the charts require additions and corrections in order to render them of the greatest service. In some cases limited surveys will be required to obtain the requisite data. Considering the extensive use made of the charts and their recognized value to the lake marine, it is recommended that the sum of $10,000 be annually appropriated for the purpose of making the necessary surveys and for correcting the engraved plates, in addition to the amount appropriated for electrotyping the plates and for chart printing. The recommendations of the past years are repeated in this respect.

Amount allotted from act approved March 2, 1889	$1,342.91
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,342.91
Amount that can be profitably expended in fiscal year ending June 30, 1892	13,000.00

(See Appendix D D D 3.)

CONSTRUCTION AND IMPROVEMENT OF ROADS AND BRIDGES IN YELLOWSTONE NATIONAL PARK.

Officers in charge, Maj. Charles J. Allen, Corps of Engineers, until November 14, 1889, and since that date Maj. William A. Jones, Corps of Engineers; Lieut. William E. Craighill, Corps of Engineers, under the immediate orders of the officer in charge. Division engineer, Col. O. M. Poe, Corps of Engineers.

The construction of roads and bridges in the Yellowstone National Park was commenced in a systematic manner in 1883, when the direction of the work was placed in the hands of an officer of the Corps of Engineers. A number of small appropriations had been expended in the endeavor to make it possible to reach the main objects of interest; access was rendered possible, but only after a tiresome trip, attended with considerable danger. Since 1883 the work has remained in charge of the Engineer Department.

At the outset the engineers adopted a project which has since been followed. It embraces a belt line road, commencing at Gardiner, on the north boundary line of the park; thence to Mammoth Hot Springs; thence to Upper Geyser Basin *via* Norris Geyser and Lower Geyser basins; thence to the outlet of Yellowstone Lake, *via* Shoshone Lake and the west arm of Yellowstone Lake, crossing the continental divide of the Rocky Mountains twice; thence to Yancey's *via* the Falls and Grand Cañon of the Yellowstone River; thence to Mammoth Hot Springs, completing a circuit of about 145 miles. There are also included in the project a road from the west boundary-line of the park to intersect the road along the Yellowstone River between the lake outlet and the Falls *via* Lower Geyser Basin; a road from Norris Geyser Basin to the Falls of the Yellowstone; a road from Yancey's to the east line of the park, and short branch roads to points of interest, comprising in all about 225 miles of new roads with necessary bridges and culverts.

During the past fiscal year 3.85 miles of new road have been built in Swan Lake Basin, around Brick Yard Hill, and in the Gibbon Cañon on the main line of travel between Mammoth Hot Springs and the geyser basins, and in the Grand Cañon of the Yellowstone River. About one-quarter (10.9 miles) of the road from Upper Geyser Basin to the outlet of Yellowstone Lake was opened up and nearly completed. Eleven trestle bridges were built, one bridge repaired, and generally the roads and important trails throughout the park were repaired and maintained.

By the close of the year 62.85 miles of new roads had been constructed, which, in connection with parts of old roads kept in condition, enabled tourists to visit Mammoth Hot Springs, Norris Geyser Basin, Lower Geyser Basin, and Upper Geyser Basin, and the Falls and upper end of the Grand Cañon of the Yellowstone River. A commencement had been made toward opening up the Shoshone and Yellowstone Lakes regions to travelers.

The dust nuisance continues to be a source of annoyance to travelers over the roads. The engineer in charge proposes to sprinkle the worst places and to organize section crews for the maintenance of the roadways and bridges in a manner similar to that in vogue with railroads.

Attention is invited to the advisability of making appropriations for this work, as for rivers and harbors, without a time limit, the money to be expended under the direction of the Secretary of War, and by him

to be applied in carrying on the work, by contract or otherwise, as may be most economical and advantageous to the Government.

With the $150,000 asked for the fiscal year ending June 30, 1892, it is expected to build 65 miles of new road toward the completion of the project and to maintain existing traveled roads throughout the park.

Amount expended during the fiscal year ending June 30, 1890, including outstanding liabilities, $50,000.

Total amount expended upon the project since commencement of work in 1883 to June 30, 1890, including outstanding liabilities, $184,779.42.

July 1, 1889, amount available		$50,000.00
July 1, 1890, amount expended-durin g fiscal year exclusive of liabilities outstanding July 1, 1889	$45,174.87	
July 1, 1890, outstanding liabilities	4,825.13	
		50,000.00
Amount appropriated by act of August 30, 1890		75,000.00
Amount available for the fiscal year ending June 30, 1891		75,000.00
Amount (estimated) required for completion of existing project		260,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892		150,000.00

(See Appendix E E E.)

MILITARY AND OTHER MAPS.

The following maps have been photolithographed and an edition printed:

Map of pier-head and bulkhead lines for the east and north shores of Staten Island, New York.

Map of pier-head and bulkhead lines for the north shore of Staten Island, New York, from New Brighton to dike opposite Elizabethport, and for the south shore of Bergen Neck, New Jersey, from East Twenty-first street, Constable's Point, to First street, Bergen Point.

Map of pier-head and bulkhead lines for the easterly shore of East River, Buttermilk Channel, Upper New York Bay, and the shores of Gowanus Bay.

Map of pier-head and bulkhead lines for the westerly shore of Hudson River, New Jersey.

Map of pier-head and bulkhead lines for the easterly shore of East River, New York, from Broadway Ferry, Brooklyn, E. D., to Ravenswood, Long Island.

Map of pier-head and bulkhead lines for the easterly shore of East River and Hell Gate from Ravenswood to Lawrence Point, Long Island.

Map of pier-head and bulkhead lines for the west shore of Arthur Kill, New Jersey, and the west and south shores of Staten Island, New York.

Map of pier-head and bulkhead lines for the east shore of Hudson River and the north and west shores of East River; also for the west shore of Hudson River.

Map of pier-head and bulkhead lines for the east, west, and north shores of Newark Bay, New Jersey.

Map of easterly shore of East River, New York, from Bushwick Creek to Grand Street Ferry, Brooklyn, E. D., showing changes in pier-head line from North First street north and east to the south abutment of bridge across Bushwick Creek at Kent avenue.

Boston Inner Harbor, Massachusetts, from bridges to upper middle channel. Boston Harbor Line Board, Sheet A.

Boston Harbor, Massachusetts. *Map of Charles River from Brookline*

Street Bridge to Charles River Bridge. Boston Harbor Line Board, Sheet B.

Boston Harbor, Massachusetts. Dorchester Bay and Neponset River. Boston Harbor Line Board, Sheet H.

Boston Harbor, Massachusetts. Charles River from Brookline Street Bridge to its mouth. Boston Harbor Line Board, Sheet I.

Boston Harbor, Massachusetts. Charles River from Brookline Street Bridge to Market Street Bridge. Boston Harbor Line Board, Sheet K.

Chart of entrance to the Columbia River, 1889.

Outline map of the United States and Territories, showing the tonnage of the navigable rivers of the United States.

MAPS OF BATTLE-FIELDS.

An edition of 1,100 copies of each sheet has been photolithographed and published of the following maps of battle-fields:

Army of the Cumberland, operations of.
Atlanta.
Atlanta campaign, sheets 1, 2, 3, 4, and 5.
Big Black River Bridge.
Bull Run, Va.
Belmont, Mo.
Chattanooga.
Charleston.
Cumberland Gap.
Carnifex Ferry.
Cincinnati, Covington, and Newport.
Central Virginia, showing General Grant's campaigns and marches.
Drainsville, Va.
Franklin.
Fort Henry.
Fort Donelson.
Forts Henry and Donelson, country between.
Fort Sumter at the time of its capture.
Five Forks.
Gauley Bridge, vicinity of.
Gettysburgh to Appomattox C. H.
Iuka.
Island No. 10 and New Madrid.
Knoxville.
Logan's Cross-Roads.
Milliken's Bend to Jackson.
Port Hudson and vicinity.
Pea Ridge.
Perryville.
Peninsula campaign, sheets 1, 2, and 3.
Roanoke Island.
Savannah, defenses of.
Spanish Fort.
Williamsport, Hagerstown, and Fallingwaters.
Williamsburg.
Yorktown, siege of.

The following battle-field maps are printed in this office to meet demands as made:

Antietam.
Appomattox C. H.
Bermuda Hundred.
Chancellorville.
Cold Harbor.
Fredericksburgh,
Gettysburgh. 3 sheets.
Harper's Ferry.
High Bridge and Farmville.
Jetersville and Sailors Creek.
North Anna.
Petersburgh and Five Forks.
Richmond.
Spottsylvania C. H.
South Mountain.
Totopotomy.
The Wilderness.
Atlanta Campaign. Index sheet.
Blakely.
Fort Fisher.
Fort Fisher and vicinity.
Nashville.
Shiloh.
General Sherman's marches.
Vicksburg.

RECONNAISSANCES AND EXPLORATIONS.

The following officers have been on duty at the headquarters of the military divisions and departments, engaged in preparing such maps and making such surveys as were required by their respective commanding officers:

Maj. Garrett J. Lydecker, Corps of Engineers, at headquarters Department of the Columbia, from August 14, 1889.

Capt. William L. Marshall, Corps of Engineers, at headquarters *Division of the* Missouri.

Lieut. Charles A. Worden, Seventh U. S. Infantry, at headquarters Department of the Platte, from August 21, 1889.

Lieut. James E. Runcie, First U. S. Artillery, at headquarters Division of the Pacific.

Maj. Garrett J. Lydecker, engineer officer, Department of the Columbia, reports that operations included resurvey of Fort Walla Walla military reservation, examination of the Spokane River from Fort Sherman to Post Falls, and examination of the Gig Harbor military reservation. Surveys were made at the Vancouver military reservation, having reference to the location of roads and fences, and the preparation and introduction of a system of sewage disposal, and irrigation of post gardens. Maps, tracings, and solar prints have been prepared and issued as required for official purposes, and additions have been made to the department map and to the map of Alaska as new information became available.

(See Appendix F F F 1.)

Capt. William L. Marshall, engineer officer, Division of the Missouri, reports that there has been no field work in progress during the year. The office work has consisted in collecting, compiling, and plotting geographical information for the improvement of existing maps; in making reductions and enlargements, and fac-simile copies and tracings of maps of military and Indian reservations, posts, scouts, reconnaissances, etc., for use at those headquarters and elsewhere in the division, for file and forwarding. During the year monthly reports of operations have been received from the engineer officers of the departments included in the division. Besides these reports these officers are required to forward such special reports and maps of work done as may be useful to the major-general commanding the division.

(See Appendix F F F 2.)

Lieut. Charles A. Worden, Seventh United States Infantry, acting engineer officer Department of the Platte, has made a report, with map, of proposed improvements in the water and sewer systems at Fort Douglas, Utah, besides numerous maps, plans, drawings, tracings, and blue prints.

(See Appendix F F F 3.)

Lieut. James E. Runcie, First United States Artillery, acting engineer officer Division of the Pacific, has made reports on the title of the United States to the military reservations on Puget Sound and the defenses to entrance to Admiralty Inlet, and on title to Peninsular Island, San Francisco Bay; surveyed and laid out known distance and skirmish ranges for the division rifle competition at Santa Cruz, Cal.; surveyed Lombard street as proposed to be graded between Presidio and Fort Mason, and surveyed additions to and alterations in roads and buildings at Fort Mason, and also made numerous maps, plans, drawings, tracings, and blue prints.

(See Appendix F F F 4.)

ESTIMATE FOR AMOUNT REQUIRED FOR SURVEYS AND RECONNAISSANCES IN MILITARY DIVISIONS AND DEPARTMENTS.

For military surveys and reconnaissances and surveys of military reservations by the engineer officers attached to the several headquarters of military divisions and departments, being an average of $1,666.66 for each of nine military divisions and departments west of the Mis-

sissippi River, $15,000; for publication of maps for use of the War Department, inclusive of war maps, $10,000; total, $25,000.

Attention is specially invited to this estimate for appropriation and to the important uses for which it is intended.

At the headquarters of the military departments west of the Mississippi River there are stationed officers of the Corps of Engineers, or other officers detailed to act, whose duty it is to make reconnaissances for military purposes, to make such surveys and prepare such maps as may be required by their respective commanding officers. In recent years no appropriations have been made for these purposes, and, consequently, these officers have been very much cramped from lack of the necessary means, and the usefulness of their offices has been very much reduced in consequence. The maps of these departments are constantly in need of revisions and additions, which the officers make so far as possible, but with no means even for the purchase of paper their efforts are limited in results.

Paragraph 383 of the Army Regulations requires that the commanding officer of each post where there are fixed batteries bearing upon a channel will call upon the Engineer Department for accurate charts showing the soundings to the extent of the ranges of the guns. Calls upon this department to perform its duty under this regulation can not be honored from lack of means.

Maps of certain military departments are now being prepared, and should be published.

Interest in the war maps published by this office and republished by virtue of the sundry civil act of March 2, 1889, continues very active. Of the 1,100 copies of each map printed under the act alluded to about three-fourths have been distributed, mainly at the request of members of Congress, and the demand bids fair to exhaust those not printed in this office (47 sheets) at an early day.

Besides all this, there is much information in this office relative to military geography which could with little expense be made available for the information of officers of the Army; for instance, there are on the office files detailed maps of regions of Europe which may become at an early day the theaters of war, and it would be of great advantage to the service if such information as these maps give could be made available for the study of officers, especially on the outbreak of hostilities. Were the means provided, this office would be glad to compile and to disseminate the information on its files.

It is the policy of this country to keep a standing army small in numbers, but it is its expectation that it should be a highly instructed one, and a small outlay as here referred to will be conducive to that end.

Applications from officers of the Army have been received for maps of certain regions of Europe, and it was with great regret that this office could not render this assistance to officers desirous of improving themselves professionally, especially when the material was on its files.

OFFICE OF THE CHIEF OF ENGINEERS.

During the fiscal year ending June 30, 1890, the following-named officers were in charge of the several divisions of the office of the Chief of Engineers:

FIRST DIVISION.—*Fortifications and Surveys relating thereto—Armament of Fortifications—Sites for Engineer Defenses—Boards of Engineers for Defenses—Public Buildings and Grounds and Washington Aqueduct.*

SECOND DIVISION.—*Battalion of Engineers—Engineer School of Appli-*

cation and Engineer Depot and Post—Professional Papers and Information—Personnel—Orders—Military Reservations—Land Files.

Capt. Clinton B. Sears until June 9, 1890, since which date Capt. John G. D. Knight.

THIRD DIVISION.—*Improvement of Rivers and Harbors and Surveys relating thereto—Bridging Navigable Waters of the United States—The removal of Wrecks Obstructing Navigation.*

Maj. Henry M. Adams.

FOURTH DIVISION.—*Accounts for Disbursements—Contracts—Returns of Engineer Property and Instruments—Application for Remittances—Appropriations and Estimates—Blank Forms.*

FIFTH DIVISION.—*Survey of the Lakes—Explorations and Surveys—Reconnaissances—Maps—Instruments—Claims.*

Capt. Thomas Turtle.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

STATEMENT SHOWING THE RANK AND THE DUTIES OF OFFICERS OF THE CORPS OF ENGINEERS DURING THE FISCAL YEAR ENDING JUNE 30, 1890.

RANK AND NAME.	DUTIES.
BRIGADIER-GENERAL AND CHIEF OF ENGINEERS.	
Thomas Lincoln Casey.	In command of the Corps of Engineers and in charge of the Engineer Department. Charged with the supervision of such matters connected with construction of jetties and other works at South Pass, Mississippi River, as require the action of the Secretary of War. In charge of the construction of the building for Library of Congress under act of October 2, 1888. Member of the Light-House Board.
COLONELS.	
George H. Mendell.....	Division Engineer of the Pacific Division. Member of The Board of Engineers when it is acting upon matters pertaining to the defensive works of the Pacific Coast. In charge of the defensive works at Alcatraz Island, at Lime Point, Fort Winfield Scott, and Battery at Fort Mason, in San Francisco Bay; and of the Battery at San Diego, Cal. In charge of construction of a torpedo-shed at Yerba Buena Island, San Francisco Harbor, Cal. In charge of the improvement of Oakland Harbor and of Napa River, Cal. In charge of survey of San Francisco Harbor, San Pablo and Suisun bays, Strait of Carquinex and mouths of San Joaquin and Sacramento rivers, Cal. To investigate causes tending to decrease depth of water and diminish the commercial value of San Francisco Harbor. Member of Boards of Engineer Officers on obstructions to navigation in the Columbia River at The Dalles and Celilo Falls, and at Three and Ten Mile Rapids; on improvement of Coos Bay, Oregon, and to establish the harbor lines of San Francisco and San Diego harbors and adjacent waters, Cal.; and to consider and report on the subject of the harbor lines at Astoria Harbor, Oregon.
Henry L. Abbot ..... *Bvt. Brig. General.*	Division Engineer of the Northeast Division. Member and President of The Board of Engineers. In charge of certain experiments with Torpedoes. Member of Board of Ordnance and Fortification. Member of Boards of Engineer Officers to consider the matter of the harbor lines of the port of Boston; to establish the harbor lines of New York Harbor and its adjacent waters; on further improvement of the harbor of Key West, Fla.; on bridges across the Charles River, owned or controlled by the cities of Boston and Cambridge; to investigate and report upon the alleged obstruction of navigation by certain bridges over the Harlem River, N. Y.; and for the examination of certain named officers of the Corps of Engineers with view to their promotion.
William P. Craighill...	Division Engineer of the Southeast Division. In charge of the defensive works at Forts Carroll and McHenry, Baltimore, Md. In charge of the improvement of the harbor at Baltimore, Md. In charge of the improvement of James River, Va., and New River, Va. and W. Va., and Gauley,

Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
COLONELS. (continued.)	
	Great Kanawha, and Elk rivers, W.Va. Member of Boards of Engineer Officers on obstructions to navigation in the Columbia River at The Dalles and Celilo Falls and at Three and Ten Mile Rapids; to establish the harbor lines of New York Harbor and its adjacent waters; of the Port of Philadelphia; and of Norfolk and Portsmouth harbors and their adjacent waters; to consider and report upon the subject of harbor lines in James River from Richmond to City Point, Va.; to establish the harbor lines of Fernandina Harbor, Fla.; and to examine and report upon plans for a bridge proposed to be built across Great Kanawa River at Charleston, W. Va. Member of the Light-House Board.
Cyrus B. Comstock .... *Bvt. Brig. General.*	Division Engineer of the Southwest Division. Member of The Board of Engineers. Member of Board of Visitors for Engineer School of Application at Willets Point, N. Y. Member and President of the Mississippi River Commission, created by act of Congress approved June 28, 1879. Member of Boards of Engineer Officers to establish the harbor lines of New York Harbor and its adjacent waters; to establish the harbor lines of the port of Philadelphia; on the proposed bridge across the Ohio River between Jeffersonville, Ind., and Louisville, Ky.; to consider and report upon Senate Bills Nos. 3901 and 3980, Fiftieth Congress, second session (bridge across Mississippi River at New Orleans, La.); to investigate and report upon the alleged obstruction of navigation by certain bridges over the Harlem River, N. Y.; to consider and report upon the terms of H. R. 10437, Fifty-first Congress, first session. (bridge proposed to be built over Mississippi River at New Orleans, La.); and for the examination of certain named officers of the Corps of Engineers with view to their promotion.
Orlando M. Poe..... *Bvt. Brig. General.*	Division Engineer of the Northwest Division. In charge of the defensive works at Fort Wayne, Mich. In charge of the improvement of the harbors at Cheboygan, Au Sable, and at Thunder Bay; harbor of refuge at Sand Beach; of the St. Mary's River, at the Falls; of the St. Clair Flats Ship-Canal; and of the rivers Detroit, Saginaw, Clinton, and Rouge, and mouth of Black River, Mich., and Hay Lake Channel of the St. Mary's River; construction of dry-dock, St. Mary's Falls Canal, and of dredging at Grosse Pointe Channel. In charge of St. Clair Flats Ship-Canal and St. Mary's Falls Canal, Mich. In charge of issuing charts of Northern and Northwestern Lakes, and of water-level observations on Lake Huron. In charge of survey of Detroit River at Gross Point, Mich. To supervise and personally examine the construction of bridge across the west channel of the Detroit River to connect Belle Isle Park with the mainland, and to supervise the construction of embankment dam on the Rapids of the St. Mary's River, between the mainland and Island No. 3; the work of making sewer outlet through United States Canal pier at foot of River street, Sault Ste. Marie, Mich.; and the work of making connection with the St. Mary's Falls Ship-Canal, for the purpose of flushing the city sewers at Sault Ste. Marie, Mich. Member of Boards of Engineer Officers on bridge across and on tunneling the Detroit River at Detroit, Mich.; and to consider and report upon *proposed* dam at Lock No. 1, Cumberland *River.*

Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
COLONELS. (continued.)	
David C. Houston	Member of The Board of Engineers. In charge of the defensive works at Forts Griswold, Trumbull, and Hale, Conn., Lafayette, Columbus, Wood, Wadsworth, and Tompkins, and its batteries, N. Y.; Castle Williams, South Battery, new Barbette Battery at Governor's Island, N. Y.; of sea-wall at same; of sea-wall and embankment at David's Island, N. Y., and of permanent platforms for modern cannon of large caliber. In charge of the improvement of the harbors of New London, Clinton, New Haven, Milford, Bridgeport, Black Rock, Stamford, Norwalk, Five Mile River, Conn., and Greenport, Port Chester, New Rochelle, Glen Cove, and of Echo Harbor, N. Y., and of the construction of breakwater at New Haven, Conn. In charge of the improvement of the rivers Housatonic and Thames, Conn., Connecticut, Mass. and Conn., Flushing Bay, and East Chester Creek, N. Y. In charge of survey of Larchmont Harbor and of Brown's Creek, N. Y. In charge of removal of the remaining pieces of wreck of steamer *Bay Ridge* from channel leading to Hempstead Harbor, N, Y. Member of Boards of Engineer Officers to establish the harbor lines of New York Harbor and its adjacent waters, and to establish the harbor lines in Stamford Harbor, Conn., and for the examination of certain-named officers of the Corps of Engineers with view to their promotion. Member of Board of Visitors for Engineer School of Application at Willets Point, N. Y.
LIEUTENANT-COLONELS.	
George H. Elliot.....	In charge of the Washington Aqueduct; increasing water supply of the city of Washington; and of the disbursement of the funds pertaining to the erection of fish-ways at Great Falls of the Potomac. Member of Board of Engineer Officers to consider the subject of laying the new 48-inch main on the Canal road, Washington, D. C.
Henry M. Robert	In charge of the defensive works at Fort Mifflin, Pa.; Fort Delaware, and fort opposite Fort Delaware, Del.; at Finn's Point, and site for defenses at Red Bank, N. J. In charge of the improvement of the harbors at Philadelphia and Delaware Breakwater; ice harbors at Marcus Hook, Pa., and the head of Delaware Bay; of the Schuylkill River, Pa.; Delaware River, from Trenton to its mouth, and Mantua Creek, N. J., and of the construction of pier near Lewes, Del. In charge of survey of Alloway Creek, N. J. In charge of removal of wreck of bark *Patriot*, lying at Delaware Breakwater Harbor, and of wrecks of coal-barges *Tonawanda*, *Wallace*, *Casilda*, and *St. Cloud*, and of bark *Il Salvatore*, in Delaware Bay. Member of Boards of Engineer Officers to establish the harbor lines of the Port of Philadelphia, and on "Surveys for Deep-water Harbor, Gulf of Mexico." Detached: Engineer Commissioner of the District of Columbia.
William E. Merrill..... *Bvt. Colonel.*	In charge of the improvement of the Ohio River, Monongahela River, W. Va., Allegheny River, Pa., and of the Muskingum River, Ohio. In charge of the construction of harbor of refuge at mouth of Muskingum River and of a dam at Herr's Island, Pa. In charge of removal of wrecks of a barge and of a coal-boat in the Ohio River at Dogham Bar and near Proctorville, Ohio, respectively. To exercise supervision over the construction of bridges

Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
LIEUTENANT-COLONELS (continued.)	
	across Ohio River at Cairo; between Cincinnati and Newport; near Ceredo, W. Va.; at Wheeling, W. Va.; between Wheeling, W. Va., and Martin's Ferry, Ohio; near the mouth of Cork's Run, in Allegheny County, Pa., and over Muskingum River, at Stockport; at Zanesville, and above the mouth of Brush Creek, Ohio. To supervise the laying of a pipe by the American Encaustic Tiling Company through the land of the United States along the bank of the canal from Second to Hughes street, Zanesville, Ohio. Member of Boards of Engineer Officers on improvement of Indiana Chute and the Falls of the Ohio at the head of the Louisville and Portland Canal; to consider and report upon proposed dam at Lock No. 1, Cumberland River, and to examine and report upon the plans for bridge across the Ohio River at Ceredo, W. Va. Engineer Fourteenth Light-house District. Representative of the Corps of Engineers to the Congress of Engineers in Paris, France.
John M. Wilson..... *Bvt. Colonel. Ex-officio Colonel of Engineers.*	In charge of Public Buildings and Grounds in the District of Columbia, with the rank of Colonel. In charge of the Washington Aqueduct; increasing water supply of the city of Washington, and the erection of fish-ways at Great Falls of the Potomac River. In charge of the improvements over the grave of Thomas Jefferson at Monticello, Va., and of the erection of a monument to mark the birth-place of George Washington. In charge of the completion, care, and maintenance of the Washington Monument. Member of the Light-house Board. Detached; Superintendent of the Military Academy.
John W. Barlow.....	In charge of the improvement of the rivers Tennessee, Tenn., Ala., and Ky.; Cumberland above and below Nashville, Ky. and Tenn.; Hiawassee, Caney Fork, French Broad, and Clinch, Tenn., and South Fork of the Cumberland, Ky. In charge of survey of Lower Cumberland River from Nashville to mouth, Tenn. To exercise supervision over the construction of bridges across the Tennessee River at or near Chattanooga; at Knoxville, and at Perryville, and of bridge across the Caney Fork River between Smith and Putnam counties, Tenn. Member of Boards of Engineer Officers to consider and report upon proposed dam at Lock No. 1, Cumberland River, and to examine and report what changes and additions are required in the Muscle Shoals canal system.
Peter C. Hains..	In charge of the defensive works at Forts Foote and Washington, Md., Wool and Monroe, Va. In charge of the improvement of the Potomac River at Washington, D. C., the establishment of the harbor lines, and the raising of the river flats. In charge of the construction of bridge across the Eastern Branch of Potomac River, D. C.; of bridge across Mill Creek; of a new wharf and of the sewerage system at Fort Monroe, Va. In charge of survey of a road from the Aqueduct Bridge to Mount Vernon. To submit a project for improving the Shenandoah River, W. Va. To report upon Senate resolution of February 20, 1890, calling for examination and report, with estimate of cost, as to most suitable kind of bridge across the Potomac River from Washington to Arlington. Member of Boards of Engineer Officers on further improvement of the harbor of Key West, Fla.; to establish the harbor lines of Norfolk and Portsmouth harbors and their adjacent waters; to consider and report upon the subject of har-

Statement showing rank and duties of officers of Corps of Engineers.—Cont'd.

RANK AND NAME.	DUTIES.
LIEUTENANT-COLONELS. (continued.)	
	bor lines in James River from Richmond to City Point, Va., and to consider the subject of laying the new 48-inch main on the Canal road, Washington, D. C. Member of The Board of Engineers while the defenses of Washington are under consideration.
George L. Gillespie	Member of The Board of Engineers. In charge of the defensive works at Forts Hamilton and Lafayette, N. Y, and Fort at Sandy Hook, N. J. In charge of the improvement of the harbors of New York, Rondout, and Saugerties, N. Y. In charge of the improvement of the Hudson and Harlem rivers, N. Y.; Raritan Bay, N. J.; channel in Gowanus Bay and Buttermilk Channel; deepening Gedney's Channel and Newtown Creek and Bay, N. Y. In charge of resurvey of public land at Sandy Hook, N. J., and of survey of Bushwick Creek; Wappinger's Creek, from Wappinger's Falls to its mouth, and of East River, with view to the removal of a ledge of rocks in the same, from foot of Broome street to the foot of Twenty-third street, in New York City, N. Y. In charge of removal of wreck of steam-ship *Atlas* from the Hudson River at New York City. In charge of the removal of obstructions in East River and Hell Gate, N. Y. To exercise supervision over construction of proposed bridge across the East River between the city of New York and Long Island. To supervise the work of making an opening in the United States dike on the right bank of the Hudson River. Member of Board of Visitors for Engineer School of Application at Willets Point, N. Y. Member of Boards of Engineer Officers to consider the matter of the harbor lines of the port of Boston; to establish the harbor lines of New York Harbor and its adjacent waters; on "surveys for Deep-Water Harbor, Gulf of Mexico;" for the examination of certain officers of the Corps of Engineers with view to their promotion; to establish the harbor lines in Stamford Harbor; on bridges across the Charles River owned or controlled by the cities of Boston and Cambridge; and to investigate and report upon the alleged obstruction of navigation by certain bridges over the Harlem River, N. Y.
Charles R. Suter.....	Member of the Mississippi River Commission created by act of Congress approved June 28, 1879. Member and president of the Missouri River Commission created by act of Congress approved July 5, 1884. To exercise supervision over the construction of two bridges across the Missouri River at or near Sioux City, Iowa; and of bridges opposite to or within the corporate limits of Nebraska City, Nebr.; at or near Nebraska City, Nebr.; at Omaha, Nebr.; between the cities of Omaha, Nebr., and Council Bluffs, Iowa; between Kansas City and Sibley, Mo.; between Leavenworth, Kans., and Platte County, Mo.; between Clay and Jackson counties; and between St. Charles and the mouth of Missouri River, Mo. Member of Boards of Engineer Officers on the proposed bridge across the Ohio River between Jeffersonville, Ind., and Louisville, Ky.; on bridge across the Mississippi River at La Crosse, Wis.; to consider and report upon bridge across the Missouri River at Clinton, Iowa; and to consider and report upon the terms of H. R. 10437, Fifty-first Congress, first session. (Bridge proposed to be built over Mississippi River at New Orleans, La.) Engineer fifteenth and sixteenth light-house districts.

Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
LIEUTENANT-COLONELS. (continued.)	
Jared A. Smith	In charge of the defensive works at Forts Knox, Popham, Gorges, Scammel, Preble, and McClary, Batteresi at Portland Head, and Gerrish's Island, Me., and at Fort Constitution and Jerry's Point, N. H. In char geof the improvement of the harbors at Bangor, Belfast, Camden, Rockport, Rockland, Portland, and York, Me., Portsmouth, N. H., harbor of refuge at Little Harbor, N. H., and the construction of breakwater from Mount Desert to Porcupine Island, Me. In charge of the improvement of the rivers Penobscot, Kennebunk, Saco, Narragaugus, Bagaduce, and Kennebec, Me., Cocheco and Bellamy, N. H., Saco River Breakwater Lubec Channel, Moose-a-bec Bar, and Back Cove, Portland Harbor, Me. In charge of survey of Belfast Harbor; Union River and Union River Bay; St. Croix River; Pleasant River, from Columbia Falls to its mouth; and Kennebunk River, Me., and Cocheco River, from Dover to its mouth, N. H. Member of Board of Engineer Officers on "Surveys for Deep-Water Harbor, Gulf of Mexico."
Samuel M. Mansfield...	In charge of the defensive works at Forts Warren, Winthrop, Standish, Andrew, Independence, and on Long Island Head, Mass. In charge of the improvement of the harbors at Newburyport, Lynn, Boston (including seawalls on Point Allerton, Great Brewster Island, Lovells' Island, Gallop's Island, Long Island Head, Rainsford Island, and Deer Island; Mystic and Charles rivers; Fort Point Channel, and channel leading to Nantasket Beach), Provincetown, Plymouth, Scituate, Hingham, Gloucester, Winthrop, Wellfleet, and Manchester, Mass. In charge of construction of a national harbor of refuge (of the first class) at Sandy Bay, Cape Ann, Mass. In charge of the improvement of the rivers Merrimac, Ipswich, and Powow, Mass. In charge of survey of Weymouth River; Salem Harbor, including South River; Beverly Harbor; and Crane River of Essex Branch, Mass. In charge of removal of wreck of schooner *John E. Sanford* in Newburyport Harbor, and of wreck of schooner *Anna A. Holton* in Provincetown Harbor, Mass. Member of Boards of Engineer Officers to consider the matter of the harbor lines of the port of Boston; and on bridges across the Charles River, owned or controlled by the cities of Boston and Cambridge.
William R. King.....	Commanding post and Engineer School of Application at Willets Point, N. Y., and the Battalion of Engineers. In charge of the defensive works at Fort Schuyler and Willets Point; of the Engineer depot at Willets Point; torpedoes for harbor defense, and experiments with the same. In charge of funds pertaining to the library of the Engineer School of Application. Member of a Board of Officers for the examination of the condition of the U. S. Artillery School at Fort Monroe, Va., and to witness the final examinations and exercises of the class of officers which will have completed the two years' course of instruction.
Wm. H. H. Benyaurd ..	In charge of the improvement of the harbors at Wilmington, San Diego, and Redwood; and construction of breakwater at San Luis Obispo Harbor, Cal. In temporary charge of the defensive works at Alcatraz Island, at Lime Point, Fort Winfield Scott, and battery at Fort Mason, in San Francisco Bay; and of the battery at San Diego, Cal.; the improvement of Oakland Harbor and of

Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
LIEUTENANT-COLONELS. (continued.)	
	Napa River, Cal.; survey of San Francisco Harbor, San Pablo and Suisun bays, Strait of Carquinex and mouths of San Joaquin and Sacramento rivers, Cal. Member of Boards of Engineer Officers to establish the harbor lines of San Francisco and San Diego harbors and adjacent waters; and on the mining débris question in the State of California, etc.
MAJORS.	
Garrett J. Lydecker....	Detached; Engineer officer Department of the Columbia. Member of General Court-Martial convened at Vancouver Barracks on January 28, 1890.
Amos Stickney	In charge of the Louisville and Portland Canal. In charge of the improvement of the Falls of the Ohio River, the Indiana Chute Fall, Ohio River, Wabash River, Ind. and Ill., and White River, Ind. To exercise supervision over the construction of bridge across the Ohio River at Louisville, Ky. In charge of the improvement of the harbors at Erie, Pa., and Buffalo, Wilson, Olcott, Oak Orchard, and Dunkirk, N. Y. In charge of the improvement of Tonawanda Harbor and Niagara River, N. Y. In charge of the preservation and protection of the peninsula of Presque Isle, Erie Harbor, Pa. Member of Boards of Engineer Officers on improvement of Indiana Chute and the Falls of the Ohio at the head of the Louisville and Portland Canal; to consider and report upon the plans for a bridge across the Ohio River at Wheeling, and to examine and report upon the plans for bridge across the Ohio River at Ceredo, W. Va.
Alexander Mackenzie ..	In charge of the improvement of the Mississippi River from Minneapolis to Des Moines Rapids; the Upper Mississippi River, and Rock Island Rapids and Des Moines Rapids of the Mississippi River. In charge of the operation of the dry-dock at the Des Moines Rapids Canal; and of harbors of refuge on Lake Pepin at Stockholm, Wis., and Lake City, Minn. In charge of operating the Des Moines Rapids Canal and of operating snag-boats and dredge-boats on Upper Mississippi River. In charge of examination and survey of the Mississippi River at Rock Island Rapids. In charge of the work in connection with the Adams Flume, Mississippi River. To supervise the work of alteration in the ponton-bridge across the Mississippi River at Prairie du Chien, Wis. To supervise the construction of bridges across the Mississippi River at Muscatine, and at Lyons, Iowa, and at La Crosse, Wis.; Member of Boards of Engineer Officers on improvement of Indiana Chute and the Falls of the Ohio at the head of the Louisville and Portland Canal; to establish the harbor lines in Quincy Bay, Ill.; on bridge across the Mississippi River at La Crosse, Wis.; to examine and report what changes and additions are required in the Mussel Shoals Canal System; and to consider and report upon bridge across the Missouri River at Clinton, Iowa. Member of the Missouri River Commission created by act of Congress approved July 5, 1884.
Oswald H. Ernst.....	In charge of public buildings and grounds in the District of Columbia, with the rank of colonel. In charge of the improvements over the grave of Thomas Jefferson at Monticello, Va., and of the erection of a monument to mark the birthplace of George Washington. In charge of the care and maintenance of the Washington Monu-

Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
MAJORS. (continued.)	
	ment. In charge of the improvement of the entrance to Galveston Harbor and of the harbor at Brazos Santiago, Tex. In charge of the improvement of ship channel in Galveston Bay, Aransas Pass and Bay up to Rockport and Corpus Christi, Buffalo Bayou, and Trinity River, Tex. In charge of survey for removal of bar at mouth of Cedar Bayou where it empties into Galveston Bay, Tex. Member of the Mississippi River Commission created by act of Congress approved June 28, 1879. Member of the Missouri River Commission created by act of Congress approved July 5, 1884. Member of Board of Engineer Officers to consider and report upon the terms of H. R. 10437, Fifty-first Congress, first session. (Bridge proposed to be built over Mississippi River at New Orleans, La.)
David P. Heap	Detached; Engineer third light-house district.
William Ludlow ..... *Bvt. Lieut. Colonel.*	In charge of the improvement of the harbors at Frankfort, Manistee, Pentwater, White River, Muskegon, Grand Haven, Black Lake, Saugatuck, South Haven, St. Joseph, and Charlevoix, and entrance to Pine Lake, and harbors of refuge at Ludington and Portage Lake, Mich., and harbor at Michigan City, Ind. In charge of the improvement of St. Joseph River, Mich., from its mouth to Berrien Springs. In charge of survey of Petoskey Harbor, Mich. To supervise the construction of bridge across Trail Creek, at Michigan City, Ind. Engineer ninth and eleventh light-house districts.
William A. Jones	In charge of the improvement of the Upper and Lower Columbia and Snake rivers, Oregon and Wash., Willamette River above Portland, and Lower Willamette River below Portland, Oregon, and Cowlitz River, Wash. In charge of survey of Upper Columbia River between Wallula and British Line. In charge of the improvement of the Chippewa River, and protection of Yellow Banks on the same; of the Minnesota and St. Croix rivers, and the Red River of the North; and of the Mississippi River above the Falls of St. Anthony. In charge of the improvement of the Yellowstone River, Mont. and N. Dak. In charge of construction and improvement of roads and bridges in Yellowstone National Park. In charge of the construction of reservoirs at headwaters of the Mississippi River and its tributaries. In charge of gauging the waters of the Mississippi River and its tributaries at or near St. Paul, Minn. In charge of the examination and surveys of the sources of the Mississippi, St. Croix, Chippewa, and Wisconsin rivers, with the view to ascertaining the practicability and cost of creating and maintaining reservoirs, etc. To exercise supervision over construction of bridges across Red River of the North at Alpha, De Mers, and Minnesota avenues, Grand Forks, N. Dak. Member of Board of Engineer Officers on improvement of Coos Bay, Oregon.
Andrew M. Damrell....	In charge of the defensive works at Forts Morgan and Gaines, Ala., and fort on Ship Island, Miss. In charge of the improvement of the harbor at Mobile, Ala. In charge of the improvement of the rivers Warrior and Black Warrior, Ala., Pascagoula, Pearl, and Noxubee, Miss., Tombigbee, Ala. and Miss., the roadstead leading into Back Bay of Biloxi in Mississippi Sound, and channel of Biloxi Bay, Miss. In charge of survey of Tombigbee River from Vienna, Ala., to Walker's Bridge, Miss. In charge of examination of Sipsey River, Ala. To exercise supervision over the construction of bridge across Tombigbee River at *Waverly, Miss.*

Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
MAJORS. (continued.)	
Charles J. Allen	In charge of the improvement of the Chippewa River, and protection of Yellow Banks on the same; of the Minnesota and St. Croix rivers, and the Red River of the North; and of the Mississippi River above the Falls of St. Anthony. In charge of the improvement of the Yellowstone River, Mont. and N. Dak. In charge of construction and improvement of roads and bridges in Yellowstone National Park. In charge of the construction of reservoirs at headwaters of the Mississippi River and its tributaries. In charge of gauging the waters of the Mississippi River and its tributaries at or near St. Paul, Minn. In charge of the examination and surveys of the sources of the Mississippi, St. Croix, Chippewa, and Wisconsin rivers, with the view to ascertaining the practicability and cost of creating and maintaining reservoirs, etc. To exercise supervision over construction of bridges across Red River of the North at Alpha, De Mers, and Minnesota avenues, Grand Forks, N. Dak. In charge of the improvement of the entrance to Galveston Harbor and of the harbor at Brazos Santiago, Tex. In charge of the improvement of ship-channel in Galveston Bay, Aransas Pass and Bay up to Rockport and Corpus Christi, Buffalo Bayou, and Trinity River, Tex. Member of Boards of Engineer Officers to establish the harbor lines in Marquette Harbor; on bridge across and on tunneling the Detroit River at Detroit, Mich.; on the proposed bridge across the Ohio River between Jeffersonville, Ind., and Louisville, Ky.; to consider and report upon Senate bills Nos. 3901 and 3980, and upon the terms of H. R. 10437, Fifty-first Congress, first session. (Bridge proposed to be built over Mississippi River at New Orleans, La.)
Charles W. Raymond ..	Detached; Engineer Commissioner of the District of Columbia. In charge of the defensive works at Fort Miffin, Pa.; Fort Delaware, and fort opposite Fort Delaware, Del.; at Finn's Point, and site for defenses at Red Bank, N. J. In charge of the improvement of the harbors at Philadelphia and Delaware Breakwater; ice-harbors at Marcus Hook, Pa., and the head of Delaware Bay; of the Schuylkill River, Pa.; Delaware River, from Trenton to its mouth; and Mantua Creek, N. J.; and of the construction of pier near Lewes, Del. In charge of removal of wrecks of three coal-barges, and of bark *Il Salvatore;* and of wreck of canal-schooner *Gen. W. T. Sherman* from Delaware Bay; and of wreck of steamer *Mediator* at Barnegat, N. J. Member of Board of Engineer Officers to establish the harbor lines of the port of Philadelphia. Engineer Fourth Light-house District, temporarily.
L. Cooper Overman	In charge of the improvement of harbors at Monroe, Mich.; Toledo, Port Clinton, Sandusky, Vermillion, Huron, Cleveland, Fairport, Ashtabula, and mouth of Black River, Ohio. In charge of improvement of Sandusky River, Ohio. In charge water-level observations on Lake Erie. In charge of removal of wreck of schooner *Joy* from Ashtabula Harbor, Ohio. Engineer tenth light-house district.
Alexander M. Miller....	In charge of the improvement of the rivers Mississippi and Missouri—removal of snags, etc.; Mississippi River between the mouths of the Illinois and Ohio rivers; Osage and Gasconade rivers, Mo. In charge of survey of Osage River, with a view to constructing locks and dams,

Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
MAJORS. (continued.)	
	Mo. To exercise supervision over the construction of bridge across the Mississippi River at St. Louis, Mo. Member of Boards of Engineer Officers to establish the harbor lines in Quincy Bay, Ill., and on bridge across the Mississippi River at La Crosse, Wis.
Milton B. Adams.....	In charge of the defensive works at Fort Montgomery, N. Y. In charge of the improvement of the harbors at Ogdensburgh, on the river St. Lawrence, Plattsburgh, and Burlington; of the channel between the islands of North Hero and South Hero, and construction of breakwaters at Rouse's Point and Gordon's Landing on Lake Champlain. In charge of the improvement of Ticonderoga and Grass rivers, and of narrows at Lake Champlain, N. Y., and Otter Creek, Vt. In charge of survey of Salmon River, and of shoals between the Sister Islands and the cross-over light in St. Lawrence, N. Y. In charge of removal of wreck of schooner *Vickery* in St. Lawrence River, N. Y. To supervise the construction of bridge across Lake Champlain at Grand Isle, Vt. In temporary charge of the defensive works at Forts Porter, Niagara, and Ontario, N. Y.; of the improvement of the harbors at Charlotte, Great Sodus, Little Sodus, Oswego, and Sacket's Harbor, N. Y.; and of water-level observations on Lake Ontario.
Wm. R. Livermore.....	In charge of the defensive works of forts at Clark's Point, Mass., Dutch Island, and Fort Adams, R. I. In charge of the improvement of the harbors of Nantucket, Wood's Holl, Wareham, Hyannis, New Bedford, and Vineyard Haven, Mass., Newport and Block Island, R. I., and Stonington, Conn. In charge of the improvement of the rivers Taunton, Mass., Pawtucket, Providence, Warren, and Pawcatuck, and Narragansett Bay, R. I., and removal of Green Jacket Shoal, Providence River, R. I. In charge of construction of draw protection at the bridge across Taunton River, Somerset, Mass. In charge of survey of Martha's Vineyard, inner and outer harbor at Edgartown, Mass.; cove near southeast extremity of Coaster's Harbor Island, and waterway between said island and Rhode Island; coast near life-saving station, East Point Judith, with a view to constructing a breakwater; and Narragansett Bay at the mouth of Narrow River, R. I. In charge of removal of wreck of schooner *Sarah L. Simmons* in Vineyard Haven Sound; of wreck of schooner *Ellen R* in Little Harbor, Wood's Holl; of wreck of schooner *Quilp* at mouth of channel leading to Cuttyhunk Pond; and of wreck of schooner *Benjamin Gartside* in Vineyard Sound, Mass. Member of Board of Engineer Officers to consider the matter of the harbor lines of the port of Boston. Member of advisory council to the Rhode Island State board of harbor commissioners.
William H. Heuer.....	In charge of the improvement of Humboldt Harbor and Bay, Cal. In charge of the improvement of the Sacramento, Feather, San Joaquin, and Mokelumne rivers, and Petaluma Creek, Cal. Member of Boards of Engineer Officers to establish the harbor lines of San Francisco and San Diego harbors and adjacent waters; and to examine and investigate the mining débris question in the State of California, etc. Engineer 12th Light-house District.

Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
MAJORS. (continued.)	
William S. Stanton	Detached; Engineer 1st and 2d Light-house districts.
Thomas H. Handbury..	In charge of the defensive works at Forts Stevens, Oreg., and Canby, Wash. In charge of the improvement of the canal at the Cascades, Oregon, mouth of the Columbia River, the Upper and Lower Columbia and Snake Rivers, Oregon, and Wash., Willamette River above Portland, and Lower Willamette River below Portland, Oregon, and of the rivers Cowlitz, Chehalis, Skagit, Stielaquamish, Nootsack, Snohomish, and Snoqualmie, Wash. In charge of water-gauges on the Columbia River from Astoria to the bar. In charge of examination and survey of the Columbia River, Oregon. In charge of survey of Upper Columbia River between Wallula and British Line. In charge of removal of wreck of the *Sylvia de Grasse* from the channel of the Columbia River opposite Upper Astoria, Oregon. Disbursing officer of Board of Engineer Officers on obstructions to navigation in the Columbia River at The Dalles and Celilo Falls, and at Three and Ten Mile Rapids. Member of Board of Engineer Officers to examine and investigate the mining débris question in the State of California, etc.; and on improvement of Coos Bay, Oregon; and to consider and report on the subject of the harbor lines at Astoria harbor, Oregon. Engineer 13th Light-house district.
James C. Post.....	Detached: Military attaché to the United States legation at London. Member of Board of Engineer Officers on obstructions to navigation in the Columbia River at The Dalles and Celilo Falls, and at Three and Ten Mile Rapids. Representative of the Corps of Engineers to the Congress of Engineers in Paris, France.
James F. Gregory.....	Detached; Engineer Secretary of the Light-house Board..
Henry M. Adams.....	In charge of the 3d Division, Office of the Chief of Engineers. Member of Boards of Engineer Officers on bridge across and in tunneling the Detroit River at Detroit, Mich.; to consider the subject of laying the new 48-inch main on the Canal Road, Washington, D. C.; to examine and report what changes and additions are required in the Muscle Shoals Canal system; and to establish the harbor lines of Fernandina Harbor, Fla.
Chas. E. L. B. Davis	In charge of the improvement of the harbors at Manistique and Cedar River, Mich., Menomonee, Oconto, Pensaukee, Green Bay, Ahnepee, Kewaunee, Two Rivers, Manitowoc, Sheboygan, Port Washington, Milwaukee, Racine, and Kenosha, Wis., and Waukegan, Ill. In charge of harbors of refuge at Milwaukee Bay, Wis., and at entrance to Sturgeon Bay Canal, Lake Michigan, Mich. In charge of the improvement of the rivers Fox and Wisconsin, Wis. In charge of survey of harbor at mouth of Fond du Lac River, in Lake Winnebago, and of Menomonee Harbor from the waters of Green Bay to N. Ludington & Company's Mill, Wis. In charge of water-level observations on Lake Michigan. To supervise the construction of bridge across Menominee River between Menomonee, Mich., and Marinette, Wis. Member of Boards of Engineer Officers to establish the harbor lines in Marquette Harbor, and to consider certain matters in connection with proposed harbor lines at Marquette, Mich.
James B. Quinn.....	In charge of the improvement of the harbors of Duluth, Grand Marais, Agate Bay, Minn., Superior Bay on Lake Superior, St. Louis Bay, and Ashland, Wis., Ontonagon,

Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
MAJORS. (continued.)	
	Eagle Harbor, and Marquette, Mich., and the harbor of refuge at Grand Marias, Mich. In charge of survey at Duluth, Minn., and at Minnesota Point, at Superior, at the west end of Lake Superior. In charge of water-level observations on Lake Superior. In charge of the establishment and maintenance of harbor lines in Portage Lake, Mich. To exercise supervision over construction of bridge across the St. Louis River between the States of Minnesota and Wisconsin. Member of Boards of Engineer Officers to establish the harbor lines in Marquette Harbor; and to consider certain matters in connection with proposed harbor lines at Marquette, Mich.
Daniel W. Lockwood...	In charge of the improvement of Little Kanawha, Guyandotte, and Buckhannon rivers, W. Va., Big Sandy River, W. Va. and Ky.; of the Kentucky, Tradewater, Green, and Barren rivers; and of Licking River from Farmers to West Liberty, Ky. To exercise supervision over the construction of the proposed road of the Carrollton or Lock No. 1, Turnpike Company, through the land of the United States at Lock No. 1, Kentucky River; of bridges across the Kentucky River at or near Tyrone, and near the mouth of Tate's Creek; and across the North Fork of Kentucky River above Beattyville, Ky. In temporary charge of the improvement of the Ohio River, Monongahela River, W. Va., Allegheny River, Pa., and of the Muskingum River, Ohio; of the construction of harbor of refuge at mouth of the Muskingum River, and of a dam at Herr's Island, Pa.; and of removal of wrecks of a barge and of a coal-boat in the Ohio River at Dogham Bar and near Procterville, Ohio, respectively. To exercise supervision, temporarily, over the construction of bridges across Ohio River at Cairo; between Cincinnati and Newport; between Wheeling, W. Va., and Martin's Ferry, Ohio; near the mouth of Cork's Run, in Allegheny County, Pa., and over Muskingum River, at Stockport; at Zanesville; and above the mouth of Brush Creek, Ohio. Member of Boards of Engineer Officers to consider and report upon bridge across the Ohio River at Wheeling; to examine and report upon the plans for bridge across the Ohio River at Ceredo; and to examine and report upon plans for a bridge proposed to be built across Great Kanawha River at Charleston, W. Va.
Ernest H. Ruffner.....	In charge of the improvement of the Mississippi River between Des Moines Rapids and the mouth of the Illinois River. Member of Board of Engineer Officers to establish the harbor lines in Quincy Bay, Ill.
CAPTAINS.	
John C. Mallery.....	Detached; Engineer fifth and sixth Light-house districts.
Clinton B. Sears	In charge of the First and Second Divisions, Office of the Chief of Engineers. Designated, in connection with the Major-General commanding the Army, to confer with the officer named by the Secretary of the Navy for the purpose of preparing a provisional programme of maneuvers for the joint naval and military operations next summer. Commanding Company A, Battalion of Engineers. Instructor in submarine mining at the Engineer School of Application.

Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
CAPTAINS. (continued.)	
Thomas Turtle.....	In charge of the Fourth and Fifth Divisions, Office of the Chief of Engineers. In temporary charge of the defensive works at Forts Carroll and McHenry, Baltimore, Md.; the improvement of the harbor at Baltimore, Md.; the improvement of James River, Va., and New River, Va. and W. Va., and Gauley, Great Kanawha, and Elk rivers, W. Va. Member of Board of Officers on revision of blank forms, etc., now in use in the Army, and for preparation of the "Book of Forms" for issue. Member of the United States Board on geographic names. Member of Board of Engineer Officers to consider and report upon the plans for a bridge across the Ohio River at Wheeling, W. Va.
Edward Maguire.....	Detached; Engineer fourth light-house district. In charge of the Louisville and Portland Canal. In charge of the improvement of the Falls of the Ohio River, the Indiana Chute Fall, Ohio River, Wabash River, Ind. and Ill., and White River, Ind. To exercise supervision over the construction of bridge across the Ohio River at Louisville, Ky. Member of Board of Engineer Officers to examine and report upon plans for a bridge proposed to be built across Great Kanawha River at Charleston, W. Va.
Frederick A. Mahan....	In charge of the improvement of the harbors at Erie, Pa., and Buffalo, Wilson, Olcott, Oak Orchard, and Dunkirk, N. Y. In charge of improvement of Tonawanda Harbor and Niagara River, N. Y. In charge of survey of the peninsula and harbor at Erie, Pa. In charge of the preservation and protection of the peninsula of Presque Isle, Erie Harbor, Pa. Detached; Engineer fourth light-house district.
Charles F. Powell.....	Secretary and disbursing officer of the Mississippi River Commission created by act of Congress approved June 28, 1879. Secretary and assistant to the construction committee of the Mississippi River Commission, and disbursing officer for works carried on by the Commission.
Frederick A. Hinman...	Found incapacitated for active service by an Army Retiring Board and granted indefinite leave of absence on account of disability.
John G. D. Knight.....	Detached; instructor of engineering at the United States Infantry and Cavalry School. Member of Boards of Officers to examine the three brick cottages built at Fort Leavenworth, Kans., to determine whether the terms of the contract for their construction have been complied with; to test a wagon fabricated by A. Melzer & Co., and designed for transportation and temporary defensive purposes; and to make a preliminary examination into the qualifications of Corporal Henry F. Hunt, Company I, Fourteenth Infantry, a candidate for promotion to the grade of second lieutenant, U. S. Army. In charge of the first and second divisions, Office of the Chief of Engineers.
Richard L. Hoxie	Commanding Company B, Battalion of Engineers. Instructor in military engineering at the Engineer School of Application. Instructor in astronomy at the Engineer School of Application. Member of General Court-Martial convened at Willets Point on May 27, 1889.
William L. Marshall ...	In charge of the improvement of the harbors at Chicago and Calumet, Ill. In charge of the improvement of the Illinois and Calumet rivers. In charge of surveys, plans, and estimates for water-way between Lake Michigan and the Mississippi River. In charge of the location, plans,

Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
CAPTAINS. (continued.)	
	and estimates of the Illinois and Mississippi Canal. Member of Boards of Engineer Officers to consider and report upon bridge across the Missouri River at Clinton, Iowa; and to consider certain matters in connection with proposed harbor lines at Marquette, Mich. Engineer officer, Division of the Missouri.
Joseph H. Willard	In charge of the improvement of Tensas River and Bayou Macon, La., Ouachita and Black River and Bayou Bartholomew in La. and Ark., Little River, Bœuf River, bayous D'Arbonne, Rondeway, and Vidal, La.; Cypress Bayou, La and Tex.; Red River, La. and Ark., Ouachita River, above Camden, Ark.; North Fork and main river of the Forked Deer River, and South Forked Deer River, and the Big Hatchie River, Tenn.; of the rivers Big Sunflower, Yazoo, Big Black, and Tallahatchie, and Tchula Lake, and Steele's Bayou, Miss. In charge of the water-gauges on the Lower Mississippi River and its principal tributaries. To supervise the construction of the bridge across Yazoo River, near Greenwood, Miss.; and of bridge across the Tensas River at Clayton's Plantation. La.; and to supervise changes and alterations in the bridge across Big Black River at Allen's Station, Miss.
Philip M. Price	In charge of the defensive works at Forts McRee, Pickens, and Barrancas, Fla. In charge of the improvement of Pensacola Harbor, Fla. In charge of the improvement of the rivers Coosa and Chattahoochee, Ga. and Ala., Flint, Ga., Choctawhatchee, Escambia, and Conecuh, Fla. and Ala., Alabama, Cahawba, and Tallapoosa, Ala., Apalachicola River and Bay, and La Grange Bayou, Fla. In charge of survey of the Coosa River for location of channel from the rapids at Wetumpka to connect with the improvements above the Ten Islands, Ala. To supervise the construction of bridge across the Chattahoochee River near Gordon; of bridge across the Alabama River near Montgomery, Ala.; and of bridge across the Flint River at Bainbridge, Ga.
Carl F. Palfrey	In charge of the defensive works at Forts Porter, Niagara, and Ontario, N. Y. In charge of the improvement of the harbors at Charlotte, Great Sodus, Little Sodus, Oswego, and Sacket's Harbor, N. Y. In charge of revision of surveys and estimates for water-way around Niagara Falls, N. Y. In charge of preliminary examination of Black River from Brownville to Lake Ontario, N. Y. In charge of water-level observations on Lake Ontario. On sick leave of absence.
William H. Bixby.....	In charge of the defensive works at Forts Macon and Caswell, N. C. In charge of the improvement of Beaufort Harbor, N. C., and Georgetown Harbor, S. C. In charge of the improvement of Cape Fear River above and below Wilmington, Roanoke, Neuse, Pamlico, Tar, Yadkin, Black, Trent, and New rivers, and Contentnia Creek, and inland water-way from New Berne to Beaufort, and inland water-way between Beaufort Harbor and New River, N. C., and Winyaw Bay, S. C. In charge of survey of Shallotte River, N. C. In charge of preliminary examination of Trent River to upper Quaker Bridge; Fishing Creek; North East River (Cape Fear), N. C.; and Roanoke River between Clarksville and Eaton Falls, Va. To exercise supervision over the construction of bridge across the Cape *Fear River at Fayetteville*, N. C. Member of Boards *of Engineer Officers on further* improvement of the har-

Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
CAPTAINS. (continued.)	
	bor of Key West, Fla.; and to consider and report upon complaints about the bridge of the New Bridge Company over the Ashley River near Charleston, S. C.
Henry S. Taber	In charge of the improvement of the Arkansas River—removal of snags, etc.; Arkansas River at Pine Bluff, and of rivers White, St. Francis, Red above Fulton, Little Red and Petit Jean, Ark., Black, Mo. and Ark.; Cache River, Ark.; Little River and St. Francis River, Mo.; and of removal of rock shoals in Fourche River, Ark. In charge of examination of Red River at railroad bridge, Fulton, Ark. To supervise the construction of bridge across the Poteau River in the Choctaw Nation, near Fort Smith; and of bridges across the Arkansas River in the Indian Territory, and at Cummings Landing, Ark.
Eric Bergland	Commanding Company C, Battalion of Engineers. Instructor in civil engineering at the Engineer School of Application. Member of General Court-Martial convened at Willets Point on November 8, 1889.
William T. Rossell	In charge of third district of the Mississippi River, from mouth of White River to Warrenton, for the purpose of improvement and the construction and repair of levees, to include the improvement of the harbor at Vicksburg, Miss. Member of Board of Engineer Officers on building and repair of levees on the Mississippi River. Detached; Assistant to the Engineer Commissioner of the District of Columbia.
Thomas W. Symons	Detached; Assistant to the Engineer Commissioner of the District of Columbia. In charge of the improvement of Tillamook Bay and Bar, harbor at Yaquina Bay, entrance to harbor at Coos Bay, and of Umpqua and Coquille rivers, Oregon; the Upper Columbia and Snake rivers, Oregon and Wash., and of the rivers Chehalis, Skagit, Stielaquamish, Nootsack, Snohomish, and Snoqualmie, Wash. In charge of survey of Umpqua River, between Scottsburgh and its mouth, Oregon. Member of Board of Engineer Officers to consider and report on the subject of the harbor lines at Astoria Harbor, Oregon.
Smith S. Leach	In charge of First District of the Mississippi River from Cairo to foot of Island No. 40, and of Second District from foot of Island No. 40 to mouth of White River, for the purpose of improvement and the construction and repair of levees. To exercise supervision over construction of bridge across the Mississippi River at Memphis, Tenn. Member of Board of Engineer Officers on building and repair of levees on the Mississippi River. On duty under the immediate orders of Lieutenant-Colonel Mansfield.
Dan C. Kingman	In charge of Fourth District of the Mississippi River, from Warrenton to Head of the Passes, for the purpose of improvement and the construction and repair of levees, to include levees and special work on the river, the improvement of the harbor at New Orleans, the Mississippi River at Natchez and Vidalia, the mouth of Red River, at the mouth of Bayou Plaquemine, and the rectification of the Red and Atchafalaya rivers at the mouth of Red River. Member of Boards of Engineer Officers on building and repair of levees on the Mississippi River; and to consider and report upon Senate bills Nos. 3901 and 3980, and upon the terms of H. R. 10437, Fifty-first Congress, first session (bridge proposed to be built over Mississippi River at New Orleans, La).

Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
CAPTAINS. (continued.)	
Eugene Griffin.....	On leave of absence. Resignation accepted by the President to take effect October 5, 1889.
Willard Young.....	In charge of the improvement of Tillamook Bay and Bar, harbor at Yaquina Bay, entrance to harbor at Coos Bay, and of Umpqua and Coquille rivers, Oregon. In charge of survey of Siuslaw River and Bar, Nehalem Bay and Bar, Young's River and its tributaries, Klaskuine River, and Umpqua River, between Scottsburgh and its mouth, Oregon. In charge of third district of the Mississippi River, from mouth of White River to Warrenton, for the purpose of improvement and the construction and repair of levees, to include the improvement of the harbor at Vicksburg, Miss. Member of Board of Engineer Officers on building and repair of levees on the Mississippi River. On leave of absence.
William M. Black.....	In charge of the defensive works at Forts Marion and Taylor, Fla. In charge of the improvement of the harbors at Key West, including entrance thereto, Tampa Bay, Cedar Keys, and St. Augustine, Fla. In charge of the improvement of the St. John's River, Volusia Bar, Caloosahatchee, Manatee, Withlacooche, Suwanee, and Pease rivers, Fla. In charge of survey of Sarasota Bay, Fla. In charge of removal of wrecks of *Transport*, *Maple Leaf*, and German brig from St. John's River between its mouth and Lake George. Member of Board of Engineer Officers to establish the harbor lines in St. Augustine Harbor, Fla.
Walter L. Fisk	In charge of the defensive works at Forts Jackson, St. Phillip, Livingston, Pike, and Macomb, Tower Dupré, Battery Bienvenue, and Tower at Proctorsville, La. In charge of the improvement of the Amite, Tickfaw, Tchefuncte, Bogue Falia, and Calcasieu rivers, bayous Terrebonne, and Courtableau, and Calcasieu Pass, La., Sabine Pass, Blue Buck Bar, and Neches River, Tex., and Sabine River, La. and Tex., Bayou Plaquemine, for securing a navigable channel up to Plaquemine Dike, and of Bayou La Fourche, La. To report upon the depth and width of a channel secured and maintained by Jetties at the mouth of the Mississippi River. Engineer seventh and eighth light-house districts.
Solomon W. Roessler...	Commanding Company A, Battalion of Engineers. Instructor in Submarine Mining at the Engineer School of Application. Member of General Court-Martial convened at Willets Point on November 8, 1889. In charge of first district of the Mississippi River from Cairo to foot of Island No. 40, and of second district from foot of Island No. 40 to mouth of White River, for the purpose of improvement and the construction and repair of levees. To exercise supervision over construction of bridge across the Mississippi River at Memphis, Tenn. Member of Board of Engineer Officers on building and repair of levees on the Mississippi River.
George McC. Derby	Detached; on duty at the Military Academy as instructor in Practical Military Engineering, and in command of Company E, Battalion of Engineers. In charge of waterworks and supply line, officer in charge of post school for enlisted men, and Acting Signal Officer at West Point N. Y. In charge of the construction of a new gymnasium at West Point, N. Y. In charge of the erection of a monument at Washington's Headquarters at Newburgh, N. Y. In temporary command of Ordnance Detachment at the *Military Academy*.

Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
CAPTAINS. (continued.)	
James L. Lusk.....	Detached; Assistant to the Engineer Commissioner of the District of Columbia.
Frederic V. Abbott.....	In charge of the defensive works at Forts Moultrie, Sumter, and Johnson, and Castle Pinckney, S. C. In charge of the improvement of the harbor at Charleston, S. C. In charge of the improvement of Lumber River, N. C.; Mingo Creek or River; Clark Creek or River; of the Ashley, Edisto, Salkiehatchie, Little Pee Dee, Great Pee Dee, Santee, Wateree, and Congaree rivers, and Wappoo Cut, S. C.; and Waccamaw River, N. C. and S. C. In charge of survey of Beaufort River, from a point three miles south of the town of Beaufort through to Coosaw River, with view to its improvement, especially at Brickyard, and of Owendaw and Wando rivers, and other waters and water-routes connecting Bull's Bay and the harbor of Charleston, S. C. In charge of removal of wreck of vessel, name unknown, from bar channel in Charleston Harbor, S. C. Member of Board of Engineer Officers to consider and report upon complaints about the bridge of the New Bridge Company over the Ashley River near Charleston, S.C.
Thomas L. Casey	In charge of the improvement of Keyport Harbor, N. J. In charge of the improvement of Arthur Kill between Staten Island and the New Jersey shore, N. Y. and N. J. In charge of the improvement of the rivers Shrewsbury, Rahway, Elizabeth, South, Raritan, and Passaic above and below Newark, N. J.; Sheepshead and Canarsie bays, and Sumpawanus Inlet, N. Y.; and channel between Staten Island and New Jersey. To supervise the use of the United States dike on Newark Bay Front, N. J., by Messrs. B. M. & J. F. Shanley. Member of Board of Engineer Officers to establish the harbor lines in Stamford Harbor, Conn. Member of Board of Officers appointed for the purpose of testing the Berdan range-finder and such other range-finders as may be recommended for test by the Board of Ordnance and Fortification.
Theodore A. Bingham..	Detached; secretary and disbursing officer of the Missouri River Commission, created by act of Congress approved July 5, 1884. Detached; military attaché to the United States Legation at Berlin.
Curtis McD. Townsend.	On duty under the immediate orders of Colonel Wilson, in connection with the Washington Aquedact and the water supply of the District of Columbia. On duty under the immediate orders of Lieutenant-Colonel Elliot. In charge of third district of the Mississippi River, from mouth of White River to Warrenton, for the purpose of improvement and the construction and repair of levees, to include the improvement of the harbor at Vicksburg, Miss. Member of Board of Engineer Officers on building and repair of levees on the Mississippi River.
FIRST LIEUTENANTS.	
Gustav J. Fiebeger.....	In charge of the improvement of the harbor at Norfolk, and the approach to Norfolk Harbor and the United States Navy-Yard, Va. In charge of the improvement of the Appomattox and Nansemond rivers, including mouths of Bennett and Chuckatuck creeks, Va., North Landing River, Va. and N. C., Currituck Sound, Coanjok Bay and North River Bar, N. C. In charge of removal of wreck

Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
FIRST LIEUTENANTS. (continued.)	
	of bark E. L. Pettingill in Chesapeake Bay, in main ship-channel to Norfolk, Va. Member of Boards of Engineer Officers to establish the harbor lines of Norfolk and Portsmouth harbors and their adjacent waters; and to consider and report upon the subject of harbor lines in James River from Richmond to City Point, Va.
Oberlin M. Carter.....	In charge of the defensive works at Forts Oglethorpe and Pulaski, Ga., and Clinch, Fla. In charge of the improvement of the harbors at Savannah and Brunswick, Ga. In charge of the improvement of Cumberland Sound, Ga. and Fla., Savannah, Altamaha, Ocmulgee, and Oconee rivers, Jekyl Creek, and Romerly Marsh, Ga. In charge of survey of Savannah River above Augusta, and between Augusta and Andersonville; and of Oconee and Ocmulgee rivers, Ga. To exercise supervision over the construction of bridge across the Oconee River at or near Dublin, Ga. Member of Boards of Engineer Officers to establish the harbor lines in St. Augustine and Fernandina harbors, Fla.; and to consider and report upon complaints about the bridge of the New Bridge Company over the Ashley River near Charleston, S. C. On duty with the Georgia militia in camp at Tybee Island, Ga.
George W. Goethals....	Detached; on duty at the military academy as Assistant Professor of Civil and Military Engineering. On duty under the immediate orders of Major Lockwood. On duty under the immediate orders of Lieutenant-Colonel Merrill. On duty under the immediate orders of Lieutenant-Colonel Barlow.
John Millis	Detached; on light-house duty under the immediate orders of Major Heap.
John Biddle	Detached; on duty as Assistant Instructor in Practical Miliary Engineering at the Military Academy, and with Company E, Battalion of Engineers. Recruiting Officer for Company E, Battalion of Engineers. Officer in charge of Post School for soldiers' children. In temporary command of Company E, Battalion of Engineers. Temporarily in charge of water-works and supply line, Officer in charge of Post School for enlisted men, and Acting Signal Officer at West Point, N. Y.; and in temporary charge of the erection of a monument at Washington's Headquarters at Newburgh, N. Y. Member of General Court-Martial convened at West Point, N. Y., December 23, 1889.
Harry F. Hodges.....	Detached; on duty at the Military Academy as Assistant Professor in Civil and Military Engineering. On temporary duty under the immediate orders of Colonel Poe. Member of General Court-Martial convened at West Point, N. Y., July, 1889.
James G. Warren	Adjutant and Treasurer of the Battalion of Engineers and Post of Willets Point, and Signal Officer and Recruiting Officer, Post of Willets Point. Commanding Company D, Battalion of Engineers. Inspector of small-arms practice, Battalion of Engineers. In charge of property pertaining to the Library of the Engineer School of Application. Member of General Court-Martial convened at Willets Point, N. Y., on May 27, 1889.
Edward Burr	On duty under the immediate orders of Major Handbury. Temporarily on duty under the immediate orders of Colonel Mendell.
Lansing H. Beach	On duty under the immediate orders of Lieutenant-Colonel Merrill. In temporary charge of the improvement of the *Ohio River, Monongahela* River, W. Va, Allegheny River,

Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
FIRST LIEUTENANTS. (continued.)	
	Pa., and of the Muskingum River, Ohio; of the construction of harbor of refuge at mouth of the Muskingum River and of a dam at Herr's Island, Pa. To exercise supervision, temporarily, over the construction of bridges across Ohio River at Cairo; between Cincinnati and Newport; between Wheeling, W. Va., and Martin's Ferry, Ohio; near the mouth of Cork's Run, in Allegheny County, Pa., and over Muskingum River at Stockport, at Zanesville, and above the mouth of Brush Creek, Ohio. In charge of removal of wrecks of a barge and of a coal-boat in the Ohio River at Dogham Bar and near Procterville, Ohio, respectively. Detached; on duty at the Military Academy in Department of Civil and Military Engineering.
Graham D. Fitch	On duty under the immediate orders of Major Davis. On duty under the immediate orders of Major Quinn.
Eugene J. Spencer.....	Detached; on duty at the Military Academy in Department of Chemistry, Mineralogy, and Geology. On duty under the immediate orders of Captain Abbot. On leave of absence.
George A. Zinn	Q. M. Battalion of Engineers. A. A. Q. M., and A. C. S., Post of Willets Point. Instructor in Military Photography at the Engineer School of Application. On temporary duty under the orders of the Secretary of State. Member of general court-martial convened at Willets Point, N. Y., May 27, 1889. Judge-Advocate of General Court-Martial convened at Willets Point, N. Y., November 8, 1889.
William C. Langfitt....	On duty under the immediate orders of Major Ernst. In temporary charge of the improvement of the entrance to Galveston Harbor and the harbor at Brazos Santiago; of the improvement of ship-channel in Galveston Bay, Aransas Pass and Bay up to Rockport and Corpus Christi, Buffalo Bayou, and Trinity River; and of survey for removal of bar at mouth of Cedar Bayou, where it empties into Galveston Bay, Tex. On duty under the immediate orders of Major Allen.
Henry E. Waterman ...	On duty under the immediate orders of Lieutenant-Colonel Barlow. On duty under the immediate orders of Major Davis.
Irving Hale.....	Detached; on duty at the Military Academy in Department of Civil and Military Engineering. Resignation accepted by the President to take effect April 1, 1890.
James C. Sanford	Detached; Military Attaché to the United States Legation at Berlin. Detached; Secretary and Disbursing Officer of the Missouri River Commission, created by act of Congress approved July 5, 1884.
Hiram M. Chittenden ..	Detached; in charge of the improvement of the Missouri River from Sioux City, Iowa, to Fort Benton, Mont., under the orders of the Missouri River Commission. In charge of survey of the boundaries of the military reservation of Fort Riley, Kans.
Cassius E. Gillette	On duty under the immediate orders of Lieutenant-Colonel Merrill.
David DuB. Gaillard ...	On duty under the immediate orders of Captain Black. Member of Board of Engineer Officers to establish the harbor lines in St. Augustine Harbor, Fla.
Harry Taylor	On duty under the immediate orders of Lieutenant-Colonel Gillespie.
William L. Sibert.....	On duty under the immediate orders of Major Lockwood.

Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
FIRST LIEUTENANTS. (continued.)	
Joseph E. Kuhn.....	On duty under the immediate orders of Major Ludlow. Detached; on duty at the Military Academy in Department of Civil and Military Engineering.
William E. Craighill...	On duty under the immediate orders or Major Allen. On duty under the immediate orders of Major Jones.
Henry C. Newcomer ...	On duty with Company C, Battalion of Engineers. Assistant Instructor in Submarine Mining at the Engineer School of Application. On duty under the immediate orders of Colonel Mendell. Member of General Court-Martial convened at Willets Point, N. Y., May 27, 1889.
Mason M. Patrick.....	On duty with Company A, Battalion of Engineers. Under instruction at the Engineer School of Application. On detached service at Johnstown, Pa., and with Pennsylvania National Guard. On duty under the immediate orders of Captain Bixby.
Charles S. Riché	On duty under the immediate orders of Colonel Poe.
Thomas H. Rees.....	On duty with Company A, Battalion of Engineers. Under instruction at the Engineer School of Application. On detached service at Johnstown, Pa. On duty under the immediate orders of Lieutenant Carter.
SECOND LIEUTENANTS.	
Charles L. Potter.....	On duty with Company C. Battalion of Engineers. Range Officer, Post of Willets Point, N. Y. Under instruction at the Engineer School of Application. Competitor in the annual rifle competitions at Fort Niagara, N. Y. Member of General Court-Martial convened at Willets Point, N. Y., May 27, 1889. On duty under the immediate orders of Captain Price.
Francis R. Shunk	On duty with Company B, Battalion of Engineers. Assistant instructor in Submarine Mining at the Engineer School of Application. Officer in charge of Post Schools, Post of Willets Point, N. Y. Acting Ordnance Officer, Post of Willets Point, N. Y. Member of General Court-Martial convened at Willets Point, N. Y., May 27, 1889.
James L. Meyler.....	On duty under the immediate orders of Lieutenant Colonel Benyaurd.
Eugene W. Van C. Lucas	On duty with Company A, Battalion of Engineers. Under instruction at the Engineer School of Application. Member of General Court-Martial convened at Willets Point, N. Y., May 27, 1889.
Henry Jervey.....	On duty with Company B, Battalion of Engineers. In charge of Post Canteen, Post of Willets Point, N. Y. Under instruction at the Engineer School of Application. Q. M. Battalion of Engineers. A. A. Q. M., and A. C. S., Post of Willets Point, for and in the absence of Lieutenant Zinn. Judge-Advocate of General Court-Martial convened at Willets Point, N. Y., May 27, 1889.
Charles H. McKinstry..	On duty with Company C, Battalion of Engineers. Mess Officer, Post of Willets Point, N. Y. Under instruction at the Engineer School of Application.
William V. Judson.....	On duty with Company A, Battalion of Engineers. Under instruction at the Engineer School of Application. On detached service with Pennsylvania National Guard.
Eben E. Winslow	On duty with Company B, Battalion of Engineers. Under instruction at the Engineer School of Application.
Albert M. D'Armit.....	On duty with Company C, Battalion of Engineers. Under instruction at the Engineer School of Application. Member of General Court-Martial convened at Willets Point, N. Y., November 8, 1889.

Statememt showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
SECOND LIEUTENANTS. (continued.)	
Clement A. F. Flagler..	On duty with Company A, Battalion of Engineers. Under instruction at the Engineer School of Application. Member of General Court-Martial convened at Willets Point, N. Y., November 8, 1889.
ADDITIONAL SECOND LIEUTENANTS.	
Chester Harding	On duty with Company B, Battalion of Engineers. Under instruction at the Engineer School of Application. Member of General Court-Martial convened at Willets Point, N. Y., November 8, 1889.
William W. Harts	On duty with Company C, Battalion of Engineers. Under instruction at the Engineer School of Application.
Robert McGregor	On duty with Company A, Battalion of Engineers. Under instruction at the Engineer School of Application.
U. S. AGENTS.	
S. T. Abert	In charge of the improvement of the harbor at Breton Bay, Leonardtown, and at entrance of St. Jerome's, Creek, Md. In charge of the improvement of Patuxent River, Md.; of the rivers Rappahannock, Chickahominy, Mattaponi, Totusky, York, Pamunky, and Staunton, Va., and Dan, Va., and N. C.; of channel in Potomac River through flats in front of landing at Mount Vernon, and of Nomini Creek, Va. In charge of survey of Chickahominy River, Occoquan and Aquia creeks, Va. In charge of removal of wreck of barge Amicus from the Pamunky River, Va.; and of wreck of canal-boat from Great Wicomico River, Va.
William F. Smith, *Major of Engineers, U. S. A., Retired.*	In charge of the improvement of the harbors at Wilmington, Del., and at Cambridge, Md., and ice-harbor at New Castle, Del. In charge of the improvement of the Maurice River, N. J., Broadkiln, and St. Jones rivers, Duck, Mispillion, and Broad creeks, Del., Susquehanna River above and below Havre de Grace; of the Choptank, Corsica, and Pocomoke rivers, and of Fairlee Creek or Inlet, Md., and inland water-way from Chincoteague Bay, Va., to Delaware Bay at or near Lewes, Del. In charge of survey of harbor at Cape Charles City and approaches by Cheuton Inlet, Onancock Harbor, and Chincoteague Inlet, Va.; Wicomico, Elk, Manokin, and Northeast rivers, and Chester River between Crumpton and Jones's Landing, Md.; and Appoquinimink Creek, Del. In charge of removal of wreck of pungy *Eva Hemingway* from Choptank River near entrance to Cambridge Harbor; of wreck of schooner *Two Brothers* from Cambridge Harbor, Md.; of boiler of wrecked steamer *Express*; and of removal of wreck of schooner *Jesse W. Knight* in Chesapeake Bay. To supervise construction of fenders for drawbridge over Broad Creek, near Laurel, Del.
U. S. CIVIL ENGINEER.	
M. Meigs	On duty under the immediate orders of Major Mackenzie.

APPENDIXES

TO THE

REPORT OF THE CHIEF OF ENGINEERS,

UNITED STATES ARMY.

APPENDIXES

TO THE

REPORT OF THE CHIEF OF ENGINEERS,

UNITED STATES ARMY.

FORTIFICATIONS, ETC.

APPENDIX No. 1.

SEA-WALL AT DAVID'S ISLAND, NEW YORK HARBOR—SEA-WALL AT GOVERNOR'S ISLAND, NEW YORK HARBOR.

REPORT OF COLONEL DAVID C. HOUSTON, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1890.

IMPROVEMENTS.

a. Sea-wall at David's Island, New York Harbor.
b. Sea-wall at Governor's Island, New York Harbor.

ENGINEER OFFICE, U. S. ARMY,
New York, July 8, 1890.

GENERAL: I have the honor to transmit herewith * * * annual reports upon sea-walls at Governor's and David's islands, New York Harbor.

Very respectfully, your obedient servant,

D. C. HOUSTON,
Colonel of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers U. S. A.

1 A.

SEA-WALL AND EMBANKMENT AT DAVID'S ISLAND, NEW YORK HARBOR.

This island, which is occupied by the recruiting service of the Army, lies at the head of Long Island Sound, about opposite New Rochelle, and is 21 miles distant by water from the Battery, New York City.

In 1883, upon recommendation of the depot surgeon, an estimate for a sea-wall was transmitted to Congress, papers concerning which were printed in House Ex. Doc. No. 205, Forty-eighth Congress, second session. The recommendation was renewed in 1884. The object first stated was to prevent the collection of garbage and refuse matter upon the shores; the second recommendation stated as an additional and important object the preservation of a fresh-water pond from overflow by the sea at high tide. The pond was separated from the sea by a narrow beach, which was not high enough to prevent waves breaking over it. This pond, formerly used as a water-supply, is now used chiefly for obtaining ice. An additional object is the reclamation of about 2 acres of low, marshy land lying back of the wall.

In 1886 a revised estimate of cost was presented as follows:

1,000 linear feet of wall, at $35 per foot	$35,000
40,000 cubic yards of earth embankment, at 30 cents per cubic yard	12,000
Total	47,000

The plan, then, was to build the wall of masonry and carry it to 12 feet above mean low-water level. The mean rise of tide is 7.3 feet.

Under the appropriations for sea-walls and embankments, approved September 22, 1888, an allotment of $47,000 was made for the above work. The plan of construction was modified to one for a riprap wall with outer slope of one on two and inner slope of one on one, to be built to 10 feet above low water and capped with a course of dimension stone 2 feet thick and 6 feet wide. The originally designed vertical masonry wall was intended to prevent lodgment of garbage, etc., but the recent stringent regulations of deposits of such matter, now being enforced in the harbor of New York and adjacent waters, will prevent any nuisance of that kind; and the riprap wall was considered equally efficient for every other purpose and more economical.

At the date of the last annual report contracts were in progress upon both the sea-wall and the embankment, 4,046 tons of riprap having been delivered in the wall and 625 cubic yards of filling in the embankment.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1890.

Work on the sea-wall was continued until April 2, 1890, when it was completed. The wall contains 9,068 tons of riprap and 953.7 linear feet of the capping course; 5,022 tons of the riprap and all of the capping were placed during the past year.

Since July 1, 1889, 27,656 cubic yards of material have been placed in the embankment, nearly completing the contract.

PRESENT CONDITION OF WORK.

The sea-wall is in good condition and is as described above.

The embankment is built to within a foot or less of the required grade everywhere except at the extreme north end, where a small space yet remains unfilled.

PROBABLE OPERATIONS.

The embankment will be completed and graded off early in the current year.

Abstract of contracts for sea-wall and embankment at David's Island, New York Harbor, in force during the fiscal year ending June 30, 1890.

Name of contractor.	Date of contract.	Subject of contract.	Price.	Remarks.
John Sheehan, New Rochelle, N. Y.	Apr. 13, 1889.	Construction of sea-wall.	Riprap per ton, $1.50; capping per linear foot, $7.	Contract completed April 2, 1890.
Do	June 1, 1889.	Delivering material and making embankment.	Filling per cubic yard, 40 cents.	Contract in progress.

1 B.

SEA-WALLS ON GOVERNOR'S ISLAND, NEW YORK HARBOR.

The shores of this island were frequently covered with offal and garbage, which, drifting up at high water and decaying in the sun as the tide fell, were (in summer) a source of constant danger to the health of the garrison. In 1865 a project was adopted providing for inclosing the entire island by a masonry sea-wall, to be built at or near low-water line, in order to prevent the lodging of such refuse matter.

Under an allotment made in 1865, 700 linear feet of masonry wall were built on the southwest side of this island in 1866; and under other smaller allotments 399 linear feet were built, making a total of 1,099 feet.

This was subsequently extended as a temporary dry wall nearly along high-water mark to Castle Williams, covering the entire southwest side of the island. By act approved August 7, 1882, $39,000 was appropriated "for completing a sea-wall already commenced on the southwest side of Governor's Island, New York Harbor, and constructing a sea-wall on its southeastern portion."

Under this appropriation and one of $15,000 made in the sundry civil bill, approved March 3, 1883, the wall was extended 206 feet along the south side of the island, and 1,502½ feet along the east side to the coal wharves. From this point the island is inclosed by wharf fronts and by the "Ordnance wall" extending around the northeast side and along the northwest side to within about 1,100 feet from the Castle Williams wall.

In 1884 an allotment of $500 was made for completing the filling and grading behind the east wall left unfinished on account of exhaustion of funds.

Under the appropriation of September 22, 1888, $50,000 was allotted for this work, and a contract dated April 4, 1889, was entered into with Francis H. Smith, of New York City, to construct a masonry wall on the north shore of the island from the existing ordnance wall to the Castle Williams wall, a distance of about 1,100 feet, at a rate of $14.70 per cubic yard of concrete foundation, $15 per cubic yard of wall, and 25 cents per pound for dowels, if required.

The construction of the sea-wall was begun the 1st of May, 1889, and up to July 1, 1889, 338 cubic yards of concrete foundation were put in, and 277 cubic yards of masonry wall were laid. The foundation was

completed a distance of 261 feet, and the wall a distance of 180 feet from the Castle Williams wall, some of the lower courses being laid for a farther distance of 50 feet.

A contract, dated May 31, 1889, was entered into with Michael Donnelly, of Brooklyn, N. Y., for making an embankment to fill the space back of the sea-wall, in process of construction, at a rate of 22½ cents per cubic yard. No work was done under this contract prior to June 30, 1889.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1890.

Work under the contract with Francis H. Smith was continued and the sea-wall was completed April 4, 1890. During the year 319.62 cubic yards of concrete foundation and 1,144.89 cubic yards of masonry wall were laid, making a total under the contract of 657.62 cubic yards of concrete foundation and 1,421.89 cubic yards of masonry wall.

Under contract with Michael Donnelly for embankment, work was begun July 6, 1889, and is still in progress. Twenty-one thousand four hundred and forty-seven cubic yards have been put in, and about 5,300 cubic yards remain to complete the contract.

PRESENT CONDITION OF WORK.

The previously-built sea walls are in good condition, except the dry-wall on the southwest side of the island, which was only temporary. The wall on the north side of the island, just completed, is 1,099.53 feet long on the top course; it breaks joints with the Castle Williams wall on the west end, and abuts against a return of the Ordnance wall on the east. It is 10 feet high, the top being 3 feet wide and 10.4 feet above mean low water, and rests on a concrete foundation 6 feet wide, extending down to firm bottom. The embankment behind the north wall is about five-sixths completed.

PROPOSED OPERATIONS.

Under the contract now in force, the embankment behind the north wall will be completed.

To complete the plan of surrounding the island by a sea-wall there remains the replacing of the dry-wall on the southwest side of the island with a masonry wall about 1,500 feet long. This, with the embankment to grade up behind it, is estimated to cost about $50,000.

Abstracts of contracts for sea-wall and embankment at Governor's Island, New York Harbor, in force during the fiscal year ending June 30, 1890.

Name and address of contractor.	Date of contract.	Subject of contract.	Prices.	Remarks.
Francis H. Smith, New York City.	Apr. 4, 1889.	Construction of sea-wall.	Concrete foundation, per cubic yard, $14.70; masonry wall, per cubic yard, $15; cramps and dowels, per pound, 25 cents.	Contract completed April 4, 1890.
Michael Donnelly, Brooklyn, N. Y.	May 31, 1889.	Delivering and placing filling.	Filling in place, per cubic yard, 22½ cents.	Contract not yet completed.

APPENDIX NO. 2.

WHARF AT FORT MONROE, VIRGINIA.—BRIDGE OVER MILL CREEK AT FORT MONROE, VIRGINIA.

REPORT OF LIEUTENANT-COLONEL PETER C. HAINS, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR FISCAL YEAR ENDING JUNE 30, 1890.

IMPROVEMENTS.

a. Wharf at Fort Monroe, Virginia.
b. Bridge over Mill Creek at Fort Monroe, Virginia.

UNITED STATES ENGINEER OFFICE,
Washington, D. C., July 1, 1890.

GENERAL: I have the honor to forward herewith my annual report for the year ending June 30, 1890, on the Fort Monroe Wharf and the Mill Creek Bridge.

Very respectfully, your obedient servant,

PETER C. HAINS,
Lieut. Col., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

2 A.

WHARF AT FORT MONROE, VIRGINIA.

The act making appropriation for sundry civil expenses of the Government for the fiscal year ending June 30, 1887, contained an appropriation of $100,000 for the construction of a new wharf and improvements to the roadway leading thereto, on the Government reservation at Fort Monroe, Va. The project adopted was the construction of a wharf on iron piles, the top of the wharf to be about 9 feet below low tide, and the site to be that of the old Baltimore Wharf. Plans and specifications were prepared, and proposals for the work were opened September 22, 1887. The Groton Bridge and Manufacturing Company of Groton, N. Y., was the lowest bidder; the bid was accepted, and a contract was made under date of October 20, 1887. This contract was supplemented on May 18, 1888, by an agreement that steel beams should be used instead of iron ones, in the construction of the wharf, and without extra cost to the Government, the contractors finding this to be to their interest because of certain existing business arrangements. At the same time the Government secured a better structure. The contractors commenced the actual work of putting down the iron piles on August 2, 1888.

By act approved August 10, 1888, an additional appropriation of $75,000 was made, to provide for the enlargement of the wharf and to make such other modifications in the plans and specifications as might be required to meet the necessities of commerce. Under the provisions of the latter act the original contract was again supplemented under date of September 28, 1888. The dimensions of the wharf were enlarged by the addition of 28 feet to the width and 42 feet to the length, all wooden bearing piles were required to be creosoted, and a wooden fender system outside the iron wharf was provided for. At the date of my last annual report the wharf was approaching completion. All the iron piles had been put in place, and nearly all of the creosoted wooden piles for the fender system had been driven. The steel beams, struts, and diagonal rods had all been put in place on the easterly section of the wharf, and the flooring of the same section nearly all laid. The old wharf had been entirely removed.

The progress of the work has been slow and unsatisfactory. Some delay and trouble was caused in sinking the iron piles, by meeting obstructions in the shape of old piles, wrecks, etc., within the limits of the site of the old wharf, but the poor business management of the contractors was the principal cause. Frequent delays were caused by having to await arrival of material, and in general there was a lack of the foresight and energetic management so necessary to insure satisfactory progress in work of this character. The construction of the wharf was completed during the latter part of September, 1889, and the structure thrown open to public use. The wharf, as completed, is of the following dimensions: Length from bulkhead to outer end, 332 feet; extreme width, 258 feet; total number of iron piles, 331. The latter were spaced 14 feet between centers.

The total quantities of materials used in the wharf were as follows:

Cast-iron piles	lbs.	1,287,079
Wrought iron and steel	do.	749,340
Creosoted wooden bearing piles		368
Fender piles		180
Mooring piles		16
Pine lumber	feet, B. M.	385,793
Oak lumber	do.	30,124
Bulkhead	linear feet.	151¼

The custody of the completed wharf was transferred to the Quartermaster's Department December 4, 1889.

The original project provided also for constructing a store-house on the wharf. Plans and specifications for a suitable building were prepared, proposals were invited by public advertisement, and were opened December 18, 1889. The following bids were received:

1. Holtzclaw Bros., Washington, D. C.	$9,499.00
2. McCarthy & Baldwin, Washington, D. C.	9,322.84
3. Darden & Ashe, Hampton, Va	7,439.67
4. A. D. Wallace, Hampton, Va	9,081.00
5. Tennis & Wheeler, Hampton, Va	8,339.00

The proposal of Darden & Ashe, of Hampton, Va., was accepted and a contract entered into under date of December 30, 1889.

The contractors have made fair progress, though some delays have occurred, and the wharf building is now nearly completed.

No work has been done by the Government on the improvements to the roadway during the year, but considerable work has been done by the Chesapeake and Ohio Railway Company, this having been made a condition of a permit granted that company to cross the Mill Creek road *at grade* when extending its railroad upon the reservation.

Money statement.

July 1, 1889, amount available	$30,619.00
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	50,454.01
July 1, 1890, outstanding liabilities	697.00
July 1, 1890, amount covered by uncompleted contracts made during the fiscal year ending June 30, 1890	5,204.67
July 1, 1890, balance available	28,540.68

---

2 B.

IRON PILE BRIDGE OVER MILL CREEK AT FORT MONROE, VIRGINIA.

The act making appropriations for sundry civil expenses of the Government for the fiscal year ending June 30, 1890, contained an appropriation of $20,000 for the construction of an iron bridge over Mill Creek between the military reservation of Fort Monroe and Elizabeth City County, Virginia. The work was assigned to my charge by letter of the Chief of Engineers, dated April 3, 1889. The approved project provided for the construction of an iron pile bridge on the site of the old wooden structure, travel not to be interrupted; the new bridge to be built of cast iron piles arranged in bents of three piles each, the piles of each bent to be 10 feet apart from center to center, and the bents to be about 20 feet apart; the iron piles to be supported by wooden piles cut off about 2 feet above the bed of the stream, the iron pile incasing the wooden one for a length of about 6 feet (or 4 feet below the bed of the creek); the floor beams to be of oak, and the width of the bridge to be 24 feet.

Plans and specifications were prepared and proposals, invited by public advertisement, were opened on July 25, 1889. The following bids were received:

1. Groton Bridge and Manufacturing Company, Groton, N. Y.	$17,500.00
2. Edward L. Dent, Washington, D. C	23,883.80
3. Sooysmith and Company, New York City	18,300.00

A contract was made with the Groton Bridge and Manufacturing Company of Groton, N. Y., under date of August 19, 1889.

The contractors commenced operations at once, and made the first shipment of iron piles from their works at Groton, N. Y., during November, 1889. Though this company was well fitted for doing the work, which was very similar to that on the Fort Monroe Wharf (constructed by the same company) they have not made as good progress as it was thought they should have done.

The work was practically completed during May, 1890, and was thrown open to travel on the 14th of that month.

Money statement.

July 1, 1889, amount available		20,000.00
July 1, 1890, amount expended during fiscal year	12,291.02	
July 1, 1890, outstanding liabilities	7,632.25	
		19,923.27
July 1, 1890, balance available		76.73

APPENDIX NO. 3.

POST OF WILLETS POINT, NEW YORK—ENGINEER SCHOOL OF APPLICATION, U. S. ARMY—BATTALION OF ENGINEERS—ENGINEER DEPOT.

REPORT OF LIEUTENANT-COLONEL WILLIAM R. KING, CORPS OF ENGINEERS, OFFICER IN COMMAND, FOR THE FISCAL YEAR ENDING JUNE 30, 1890.

ENGINEER SCHOOL OF APPLICATION, U. S. ARMY,
Post of Willets Point, New York Harbor, July 25, 1890.

GENERAL: I have the honor to submit the following annual report on the post of Willets Point, New York Harbor, the United States Engineer School, the Battalion of Engineers, and the Engineer Depot.

POST OF WILLETS POINT

At the close of the fiscal year the garrison consisted of 28 commissioned officers and 384 enlisted men, including the following General Staff, Artillery and Infantry Officers:

Major Clarence Ewen, Surgeon, U. S. Army.
Captain Henry S. Kilbourne, Assistant Surgeon, U. S. Army.
First Lieutenant Adam Slaker, First Artillery.
First Lieutenant Edgar W. Howe, Seventeenth Infantry.
First Lieutenant John H. Beacom, Third Infantry.
First Lieutenant Victor E. Stottler, Tenth Infantry.
Second Lieutenant Frank L. Winn, First Infantry.
Second Lieutenant Richard C. Croxton, Fifth Infantry.
Second Lieutenant George F. Landers, Fourth Artillery.
Second Lieutenant Harry E. Wilkins, Second Infantry.
Second Lieutenant Samuel Seay, Jr., Twenty-first Infantry.

Maj. Clarence Ewen, surgeon U. S. Army, was assigned to duty at this post January 2, 1890, in compliance with special orders No. 242, Headquarters of the Army, Adjutant-General's Office, Washington, October 17, 1889.

Capt. Henry S. Kilbourne, assistant surgeon U. S. Army, was assigned to duty at this post June 12, 1890, in compliance with special orders No. 93, Headquarters of the Army, Adjutant-General's Office, Washington, April 21, 1890.

First Lieut. Theodore F. De Witt, assistant surgeon, U. S. Army, was relieved from duty at this post, June 4, 1890, in compliance with special orders No. 119, Headquarters of the Army, Adjutant-General's Office, Washington, May 21, 1890.

Capt. Edward C. Carter, assistant surgeon, U. S. Army, was relieved from duty at this post January 2, 1890, in compliance with special orders No. 287, Headquarters of the Army, Adjutant-General's Office, Washington, December 20, 1889.

The following-named officers were relieved from duty at this post (instruction in submarine mining) at the dates set opposite their respective names, viz:

Second Lieut. William S. Biddle, jr., Thirteenth Infantry, September 23, 1889.
First Lieut. David Price, First Artillery, October 1, 1889.
First Lieut. Charles B. Hardin, Eighteenth Infantry, October 1, 1889.
Second Lieut. James T. Kerr, Seventeenth Infantry, October 1, 1889.
Second Lieut. Elmer F. Taggart, Sixth Infantry, October 1, 1889.
Second Lieut. Tredwell W. Moore, Twenty-second Infantry, October 1, 1889.
Second Lieut. Edward N. Jones, jr., Eighth Infantry, October 1, 1889.

Second Lieut. Lorenzo P. Davidson, Eleventh Infantry, whose tour of duty and instruction at the post was, upon his own application, extended until May 1, 1890, as per letter dated War Department, Adjutant General's Office, Washington, September 12, 1889, was relieved on May 1, 1890, in compliance with special orders No. 97, Headquarters of the Army, Adjutant-General's Office, Washington, April 25, 1890.

Two artillery officers and eight infantry officers were assigned to duty at this post in special orders No. 246, Headquarters of the Army, Adjutant-General's Office, Washington, October 22, 1889.

Second Lieut. Maury Nichols, Sixteenth Infantry, was, upon his own request, relieved from duty at this post on February 10, 1890, in compliance with special orders No. 30, Headquarters of the Army, Adjutant-General's Office, Washington, February 5, 1890.

The following improvements are about all that could be accomplished with the means available during the year:

I. The roads and walks about the post have been repaired with broken stone furnished by the Quartermaster's Department.

II. The cooking facilities of the battalion mess, which was started about the beginning of the fiscal year, have been improved by the addition of mammoth steam coffee-boilers, soup-stock boiler, and a steam-heating table, which is being constructed. An instructor in cooking was employed for several months. It is believed that when a suitable building is provided for this mess the results will be all that have been anticipated.

III. Water-closets have been introduced into the quarters of six non-commissioned officers, and two large brick water-closets have been built near the barracks for the use of enlisted men.

IV. A small portion of the parade ground has been graded by removing the sod, and filling up the worst inequalities, and this work should be extended, though there is too much of it to be done entirely by the labor of enlisted men.

V. The fire-proof building for engineer models, referred to in last report, is well under way. Nearly all the materials have been procured, the foundations laid, and the walls are up to the middle of the first story.

VI. Plans and estimates for lighting the public buildings and grounds by electricity, as suggested in my last report, have been made and forwarded March 26, 1890, to the Quartermaster-General, and it is hoped that the experiment may be tried at an early day. The cost of dynamo, wiring and lamps will be only about $2,000, and the experience gained by the introduction of this plant may be utilized in supplying other military posts with the best and safest of lights.

VII. New plans have been made for a quartermaster and commissary store-house, which will somewhat diminish the cost, and give sufficient accommodations for offices and storage.

VIII. The coal-shed, recently authorized for the annual supply of *coal, near the* quartermaster's wharf, is well under way, and it is ex-

pected that a great saving will result in the cost of hauling coal, and additional economy will result from having the coal protected from the weather.

IX. The cemetery fence has been painted, and it is very desirable that suitable headstones should be provided for soldiers' graves. Thirty-three soldiers have been buried in this cemetery, and seven of them have had marble head-stones erected by their comrades, while twenty-six graves are marked by wooden head-boards, which are fast going to decay.

No additional interments are to be made in this cemetery, but it should be placed in good repair, and all perishable monuments should be replaced at once.

X. Some repairs and improvements have been made to the post canteen, and it has continued in successful operation from the start. The net proceeds of the canteen divided among the companies during the past year has been $3,468.26. The chief object of the canteen, however, is not to make money, but to encourage the men to remain on the post, and not patronize the numerous rum-shops in the immediate neighborhood. The effect on the discipline of the garrison has been constantly kept in view, and while some abuses of the canteen privileges have been noticed, it has been quite evident that nearly all the delinquencies during the year have been committed by men who had patronized the saloons off the post.

The following additional improvements, most of which have been referred to in former reports, are earnestly recommended:

I. The new barracks and mess-building, for which plans and specifications have been submitted.

As there was an item of $60,000 among the estimates of the Quartermaster-General on which a large appropriation was made in the army bill, and as the Secretary of War and the Chief of Engineers have personally inspected the post recently, it will not be necessary to enlarge upon this item.

II. As an allotment of $1,200 has been made for cleaning out and deepening the ditch on the west side of the post, this much needed work will be done during the present year.

III. It has been my intention to build a wall and embankment around the ice pond, so as to prevent surface-water from entering it directly, but it has not been possible to do so with the labor of the post without increasing the fatigue details beyond a reasonable limit.

The wall will have to be 300 yards long, and with the stone already on hand for the purpose, and using the labor of the post when available, the work could be done for $900.

This will not only remove the unsanitary margin of swamp in summer, but would improve the quality of the ice in winter. The post surgeon has heretofore declared the ice unfit for use except for indirect cooling purposes.

IV. Some second-hand iron fence has been procured, and it is proposed to erect it on the reservation line adjoining the new gates, and this, with the deepening of the ditch already provided for, will form a suitable inclosure of the Government lands.

V. In order to accommodate as many student officers as possible, the available quarters for unmarried officers have been crowded to their utmost capacity, and it is respectfully recommended that an allotment be made, if possible, for a single set of quarters suitable for one of the captains, and the quarters now occupied by him will then be available for two lieutenants.

VI. The health of the post during the past year has been excellent.

There were no deaths in the command, and no serious epidemics. The number of men on sick report has been only about two-thirds of the average for the past five years.

In this connection I desire to invite attention to the fact that the medical statistics as published by the Surgeon-General have given this post a very undeserved reputation for unhealthfulness, ranking it far below Jackson Barracks and Fort Barrancas. In fact, there are but two posts in the entire list that have so large a percentage of men "admitted to hospital."

The facts, I think, show conclusively that a very large "personal equation" should be applied to all these statistics.

ENGINEER SCHOOL OF APPLICATION, U. S. ARMY.

The scope and object of the school have been fully set forth in previous reports and in the order establishing it on its present basis; the orders issued in pursuance of the latter, arranging the details of the season's work, are appended, marked A, B, and C.

During the past year a class of two engineer officers completed the full course of three years, and one officer of artillery and six officers of infantry, having completed the ten months' course of torpedo instruction, were relieved in October.

The following tabular statement shows the constitution of each class, the subjects in which they have received instruction, and their marks in each subject for the year, the maximum in all cases being 3.

These marks are the mean of marks awarded at examinations held as follows, viz: January 3, 1890. February 7, 1890. March 7, 1890. May 6, 7, 1890.

Third winter's class.	Civil engineering.	Military engineering.
Second Lieutenant Francis R. Shunk, Corps of Engineers	2.81	3.00
Second Lieutenant E. W. Van C. Lucas, Corps of Engineers	2.76	2.82

Second winter's class.	Civil engineering.	Military engineering.	Photography.
Second Lieutenant E. W. Van C. Lucas, Corps of Engineers*	.....	.....	2.2
Second Lieutenant Henry Jervey, Corps of Engineers	2.63	2.64	2.8
Second Lieutenant C. H. McKinstry, Corps of Engineers	2.77	2.76	2.9
Second Lieutenant W. V. Judson, Corps of Engineers	2.81	2.79	2.7

First winter's class.	Civil engineering.	Torpedoes.
First Lieutenant Adam Slaker, First Artillery	.....	2.886
First Lieutenant Edgar W. Howe, Seventeenth Infantry	.....	2.884
First Lieutenat John H. Beacom, Third infantry	.....	2.252
First Lieutenant Victor E. Stottler, Tenth Infantry	.....	2.510
Second Lieutenant Frank L. Winn, First Infantry	.....	2.692
Second Lieutenant Richard C. Croxton, Fifth Infantry	.....	2.118
Second Lieutenant George F. Landers, Fourth Artillery	.....	2.898
Second Lieutenant Harry E. Wilkins, Second Infantry	.....	2.522
Second Lieutenant Samuel Seay jr., Twenty-first Infantry	.....	2.622
Second Lieutenant E. E. Winslow, Corps of Engineers	2.85	2.980
Second Lieutenant A. M. D'Armit, Corps of Engineers	2.90	2.920
Second Lieutenant C. A. F. Flagler, Corps of Engineers	2.59	2.758
Additional Second Lieutenant Chester Harding, Corps of Engineers	2.63	2.846
Additional Second Lieutenant W. W. Harts, Corps of Engineers	2.25	2.876
Additional Second Lieutenant Robert McGregor, Corps of Engineers	2.30	2.868

*Examined with this class in photography only.

The library of the school is under the immediate charge of the battalion adjutant, *ex officio* secretary of the academic staff, and has received many valuable additions during the year in the way of standard scientific works and periodicals.

The appropriation asked for to keep the library up to the proper standard during the next fiscal year is $500, which is respectfully recommended.

In accordance with my recommendation of last year, the course of instruction in torpedo service, for officers of artillery, cavalry, and infantry was extended from seven months to ten months, commencing on the 1st day of December, and ending on the 1st day of October following. (General Orders, No. 47, Headquarters of the Army, Adjutant-General's Office, Washington, April 29, 1889.)

In response to a circular sent to officers of the Corps of Engineers, some valuable contributions to the collection of engineer models have been received, among which are the following, viz:

I.—A model of the movable dam as applied to the Kanawha River, West Virginia, by Col. William P. Craighill.
II.—A shot and shell taken from the walls of Fort Pulaski, Georgia, and a palmetto log, from Lieut. O. M. Carter.
III.—A "dead-light" from the steamer *Star of the West*, from Capt. J. H. Willard.
IV.—A shell from the battle-field of Bull Run, from Capt. F. A. Mahan.
V.—A set of blue prints of the proposed locks and other structures on the Hennepin canal, from Capt. W. L. Marshall.
VI.—A set of blue prints of a combined wagon and shield, from Capt. John G. D. Knight.
VII.—Photographic views of Works on Plum Point and Memphis reaches, from Capt. S. S. Leach.
VIII.—Model of crib designed for breakwater at Michigan City, Ind., from Lieut. Joseph E. Kuhn.
IX.—Blue print of proposed new lock at St. Mary's Falls Canal, Michigan, from Col. O. M. Poe.
X.—Photographic views of Mexican works of bank protection opposite El Paso, Tex., from Maj. O. H. Ernst.
XI.—Drawings of breakwater cross-section at Lake Champlain, from Maj. M. B. Adams.
XII.—Model of crib and riprap foundation at Milwaukee, and model of lock-gate on Fox River, from Maj. C. E. L. B. Davis.

BATTALION OF ENGINEERS.

The law provides for five companies of engineer troops, having an aggregate strength of 752 enlisted men, officered by detail from the Corps of Engineers. At present only four companies, with a total strength of 500 enlisted men, are allowed to be recruited.

The aggregate strength of the battalion on June 30, 1890, including Company E, stationed at West Point, N. Y., was 19 commissioned officers and 459 enlisted men.

During the year Companies A, B, and C, have been stationed at Willets Point. Company D exists in name only. Company E, has been stationed at West Point, to assist in the practical instruction of cadets of the Military Academy, in building military bridges, sapping, mining, and signaling.

The following is a roster of officers serving with the Battalion of Engineers on June 30, 1890, viz:

Lieut. Col. William R. King, Corps of Engineers, commanding.
First Lieut. James G. Warren, Corps of Engineers, adjutant.
First Lieut. George A. Zinn, Corps of Engineers, quartermaster.

Company A.

Capt. Clinton B. Sears, Corps of Engineers, commanding company.
Second Lieut. Eugene W. Van C. Lucas, Corps of Engineers, with company.
Second Lieut. William V. Judson, Corps of Engineers, with company.
Second Lieut. Clement A. F. Flagler, Corps of Engineers, with company.
Additional Second Lieut. Robert McGregor, Corps of Engineers, with company.

Company B.

Capt. Richard L. Hoxie, Corps of Engineers, commanding company.
Second Lieut. Francis R. Shunk, Corps of Engineers, with company.
Second Lieut. Henry Jervey, Corps of Engineers, with company.
Second Lieut. Eben E. Winslow, Corps of Engineers, with company.
Additional Second Lieut. Chester Harding, Corps of Engineers, with company.

Company C.

Capt. Eric Bergland, Corps of Engineers, commanding company.
Second Lieut. Charles H. McKinstry, Corps of Engineers, with company.
Second Lieut. Albert M. D'Armit, Corps of Engineers, with company.
Additional Second Lieut. William W. Harts, Corps of Engineers, with company.

Company D.

First Lieut. James G. Warren, Corps of Engineers, commanding company.

Company E.

Capt. George McC. Derby, Corps of Engineers, commanding company.
First Lieut. John Biddle, Corps of Engineers, with company.

The following table shows the changes that have taken place in the personnel of the officers during the year, viz:

Rank.	Names.	Date.	Relieved or joined.	Remarks.
First lieutenant	Newcomer, H. C	Aug 28, 1889	Relieved	S. O., No. 188, A. G. O., Aug. 15, 1889.
Do	Patrick, M. M	Oct. 7, 1889	do	S. O., No. 226, A. G. O., Sept. 28, 1889.
Second lieutenant	Rees, Thos. H	do	do	Do.
Do	Potter, C. L	Oct. 9, 1889	do	Do.
Captain	Roesler, S. W	June 14, 1890	do	S. O., No. 127, A. G. O., May 31, 1890.
Second lieutenant	Winslow, E. E	Sept. 30, 1889	Joined	S. O., No. 208, A. G. O., Sept. 7, 1889.
Do	D'Armit, A. M	do	do	Do.
Do	Flagler, C. A. F	do	do	Do.
Additional second lieutenant.	Harding, Ches	do	do	Do.
Do	Harts, W. W	do	do	Do.
Do	McGregor, Rob	do	do	Do.
Captain	Sears, C. B	June 24, 1890	do	S. O., No. 127, A. G. O. May 31, 1890.

RECRUITING.

During the year the companies of the Battalion of Engineers have been recruited partly by enlistment and re-enlistment at Willets Point and West Point, partly by assignment, on their own application, of recruits from Princeton Depot Recruiting Service at Davids Island, New York Harbor, and Columbus Barracks, Ohio, and partly by recruits obtained at a rendezvous in New York City.

The Engineer sergeant detailed to recruit for the Battalion of Engineers, under authority granted in letter from the Adjutant-General,

U. S. Army, dated September 15, 1888, and attached by the superintendent recruiting service to Rendezvous 146, Park Row, New York City, was relieved from this duty March 27, 1890, only ten recruits being at that time required to complete the authorized strength of the companies at this post.

The following is a summary statement of the recruiting, desertions, and other changes among the enlisted men of the Battalion of Engineers during the past year, viz:

Gain:	
Recruits from depot (from Davids Island, 12; from Columbus Barracks, 13)	25
Enlisted (at Willets Point, 101; at West Point, 46)	147
Re-enlisted (at Willets Point, 56; at West Point, 8)	64
By transfer (transferred upon their own application)	11
From desertion	6
Total	253
Loss:	
Discharged by expiration of service	96
Discharged for disability	10
Discharged by general court-martial	7
Discharged by order	21
Transferred (ill health, 2; hospital corps, 1; other causes, 6)	9
Retired	3
Died	0
Deserted (Co. A, 15; Co. B, 11; Co. C, 22; Co. E, 4)	52
Total	198

Net increase, 253, less 198=55 men.

The following table exhibits a synopsis of the Engineer recruiting service, the average number of men in confinement and sick, the number of desertions, and trials by general and garrison courts-martial from June 30, 1884, to June 30, 1890, a period of six years, viz:

Fiscal year.	Number of men on June 30.	Recruiting.		Average daily number.		Desertions.	Trials.	
		Enlisted.	Re-enlisted.	Confined.	Sick.		General court-martial.	Garrison court-martial.
June 30, 1884, to June 30, 1885	383	56	30	6	18	106	11	59
June 30, 1885, to June 30, 1886	396	57	38	8	22	76	20	107
June 30, 1886, to June 30, 1887	388	29	28	9	17	49	19	160
June 30, 1887, to June 30, 1888	397	9	24	12	22	49	21	218
June 30, 1888, to June 30, 1889	402	90	29	6	20	22	4	214
June 30, 1889, to June 30, 1890	468	147	64	9	14	52	13	304

NOTE.—The figures for 1888, 1889, and 1890, include nine men in hospital corps, who were formerly detailed from this battalion.

From this table it will be seen that the enlisted strength of the battalion is one sixth greater than at any previous time; that the number of men enlisted during the year has been more than three times and the number re-enlisted has been more than double the average of former years. The per cent. of men in confinement has been about the average, while the proportion of men on sick report has been *only two-thirds as large* as the average number.

The number of desertions has been more than double the number last year, but is much less than the average of the past five years; and, as compared with the number of men in the first year of their enlistment, the class that furnishes most of the deserters, the proportion is even less than that of *last year.*

The number of trials by general court-martial has been less than the average, while the number of trials by garrison courts has been considerably greater. This increase has been largely due to the natural bent of some men to abuse any privileges accorded them. A large proportion of these cases have arisen from the substitution of a check roll-call at 11 o'clock for tattoo roll-call at 9.30 o'clock, and it is believed that the service would be the better for requiring men to retire at any early hour, as a rule, and making such exceptions as circumstances may require by the liberal use of passes.

The following statement shows the number of different men tried and other facts relative to the trials:

	Trials.
By general court	13
By garrison court	304
Total	317

	No. of men.	No. of trials.
Tried once	75	75
Tried twice	37	74
Tried three times	10	30
Tried four times	14	56
Tried five times	8	40
Tried six times	2	12
Tried seven times	2	14
Tried eight times	2	16
Total	150	317

Number of men who pleaded guilty	264
Number of men who pleaded not guilty	53
Total	317
Number of acquittals	15
Number found guilty	302
Total	317

From this it appears that less than one-third of the battalion were tried for any delinquency whatever during the year, while only thirty-eight men, or less than *one-twelfth* of the number in the battalion, were accountable for more than *one-half of all the court-martial cases.*

This points to the liberal discharge of bad men for the benefit of the service as a wholesome measure, as the dishonorable discharge of about 8 per cent. of the battalion would have improved the discipline, as shown by court-martial cases, 50 per cent. and would also have prevented many desertions, as several of these same men afterwards deserted.

The statement also shows that in over 80 per cent. of cases the accused *pleaded* guilty, and he was *found* guilty in about 95 per cent. of the cases.

These facts, I think, accord with the suggestions expressed in my last report, viz:

II. Allow cases of desertion to be tried by garrison courts, unless the accused demands a general court and award suitable punishment, subject to the approval of the General of the Army.

III. Allow minor offenses, now triable by garrison courts, to be tried, and punishment such as fine or confinement at hard labor, awarded by a field officer or a captain other than the commanding officer of the prisoner, unless the latter demands a garrison court; the sentence to be subject to approval of the post commander.

The last two suggestions would, I think, tend to secure prompt as well as substantial justice, and thus save valuable time as well as give the prisoner a speedy trial. In the great majority of cases the prisoner pleads guilty and makes no defense; in *fact, charges are* seldom preferred without a previous investigation. If the man does

not even pretend that he is innocent, why should the legal farce of a formal trial be enacted? When any doubtful case arises the prisoner can secure his rights as at present by asking for a court, but in the general case he would prefer to be sentenced at once, so as to avoid delay.

DRILLS AND INSTRUCTION.

During the year the Battalion of Engineers has been drilled and instructed as follows:

1. Infantry tactics, school of the soldier, company and battalion.

2. In target practice. Target practice which was suspended on June 11, 1889, was resumed on July 21, 1889. The practice season for the post of Willets Point, New York Harbor, for the past target year, prescribed in General Orders No. 3, Headquarters Corps of Engineers, series of 1889, was extended for one month, to date from return of engineer detachment at Johnstown, Pa.

In last target year, two men qualified as sharpshooters, and twenty-one as marksmen.

In the rifle contest at Fort Niagara, five prizes of the available twenty were won by the battalion team, as follows:

In the Department of the East match: Number of competitors, 70; average of twelve highest scores, 524.

Corporal Truman Organ, Company E, won first prize, gold medal; score, 554; highest score last year, 531. Second Lieut. Charles L. Potter, Corps of Engineers, won second prize, silver medal; score, 550; highest score last year, 531. Sergeant William A. Boyle, Company C, won third prize, silver medal; score, 546; highest score last year, 522.

In the Division of the Atlantic match: Number of competitors, 28; average of twelve highest scores, 514.

Second Lieut. Charles L. Potter, Corps of Engineers, won fourth prize, gold medal; score, 518; highest score last year, 511. Corporal John Kelly, Company A, won seventh prize, silver medal; score, 510; highest score last year, 507.

Thus making one-fourth of the twenty available prizes with about one-twentieth of the number of competitors.

These results are especially creditable in view of the limited time and imperfect facilities available for target practice at this post.

3. In pontoniering during the months of August and September. (Drills in the use of United States bridge equipage.)

4. In military engineering. Nomenclature, dimensions, profiling, and construction of modern siege batteries; foot reconnaissances, during the months of October and November, 1889.

5. Torpedo drills were had throughout the year; the winter months being devoted to in-door drills and practice in the loading room, and the summer months to out-door drills and exercises.

The following number received instruction during the winter months, viz: Sixteen sergeants, 22 corporals, and 281 privates.

Qualification of privates:	
First class	162
Second class	92
Third class	27
	281
Excused, being already rated as first class in torpedo service	12
	293

6. Photography. Selected details of non-commissioned officers have been instructed in military *photography*.

The detachment of engineer troops consisting of Second Lieuts. Mason M. Patrick and Thomas H. Rees, Corps of Engineers, 4 sergeants, 1 corporal, and 47 privates, returned with ponton material, etc., from Johnstown, Pa., on July 16, 1889. This detachment, balance of original force sent from here on June 5, 1889, under command of Capt. Eric Bergland, Corps of Engineers, was employed in guarding and preserving ponton material, etc., in use at that place, and in constructing bridges of a more permanent character across the Conemaugh River and Stony Creek, at Johnstown, Pa.

In compliance with telegraphic instructions from the Chief of Engineers, U. S. Army, a detachment of 3 sergeants, 5 corporals and 21 privates, under command of First Lieut. Mason M. Patrick and Second Lieut. William V. Judson, Corps of Engineers, was sent to Philadelphia, Pa., on August 5, 1889, to report to the governor of Pennsylvania, for assignment to duty with the First Brigade, Pennsylvania National Guard. The detachment was supplied with intrenching tools for 300 men, and with tools for preparing siege material; and were prepared to give instruction in aiming drill, target practice, manufacture of siege material, tracing and profiling of field works, construction of hasty intrenchments, rifle pits, etc., and reconnaissances. On account of limited time, but little was accomplished. The detachment returned on August 13, 1889.

ENGINEER DEPOT.

PUBLIC BUILDINGS AND CONSTRUCTIONS.

I. The new fire-proof building for engineer models is well under way, the walls being completed up to the middle of the first story and nearly all the materials having been procured. All the work thus far has been done by engineer soldiers and the building will be a monument to their skill as draughtsmen, stone-cutters, masons, bricklayers, carpenters, blacksmiths, and painters, and it is an important fact that the best mechanics and most intelligent clerks are also in very many cases the best soldiers.

II. On the 10th of May, 1890, one of the store-houses for engineer tools and ponton-bridge equipage was destroyed by fire, together with all of its combustible contents. The fire was evidently the work of an incendiary, and owing to a combination of unfavorable circumstances it was found impossible to save any part of the building, which was a mere shell of boards and shingles. The fire was started near the middle of the building where there was a large quantity of pitch, axle-grease, and dry pine lumber, this grease and lumber having been on hand ever since the close of the war in 1865. The flames from the grease and pitch spread almost instantly throughout the building, and coming out through the shingles soon had the entire building as well as its contents wrapped in flames. Several pieces of hose burst as soon as the water was turned on, and although every effort was made with the appliances on hand, and one good stream of water was maintained from the first, it was found impossible to check the flames.

Most of the property destroyed was old materials saved from the war and will not have to be replaced, as it was retained chiefly because it was too good to throw away and yet had very little market value. Of this character was the large quantity of obsolete bridge materials, eleven thousand picket shovels and parts of the Repsold base apparatus. The building itself was much larger than will be needed hereafter, and *it is proposed to* build a much smaller one of brick and other fire-proof

materials, to contain such articles, intrenching tools and ponton materials, as will be needed. A building 40 by 100 feet will answer the purpose and can be built for $16,000. An appropriation of this amount is respectfully recommended. No special appropriation is asked to replace the materials destroyed, but it is recommended that the next annual appropriation for "materials for instruction of engineer troops at Willets Point in their special duties as sappers and miners and pontoniers" be increased to $4,500.

III. Plans and drawings have been made for a small tug to be used in place of the boat known as the *Great Eastern*, for planting torpedoes, and a pair of engines, already on hand, suitable for such a boat, are being fitted up for the purpose. It has been found, both in this country and in England, that a small, inexpensive steamer, about 45 feet long, that can start, stop, and turn promptly, is much handier for such purposes than larger and more costly vessels. They can be used in most cases when the water is sufficiently smooth to plant torpedoes at all, and will do their work as rapidly as the larger vessels, the torpedoes, cables, and anchors being kept at a convenient point on an old lighter or other suitable craft.

For occasional work the hull of the cat-boat *Queen* has been decked over, and can be used in planting torpedoes, the tug *Raritan* being used to tow her about.

IV. A temporary shelter has been provided for the new "Mangin projector" and its carriage, in the end of the large frame store-house near the long wharf. This room was recently vacated by the ordnance sergeant, who now has his property stored in one of the old engineer boarding-houses that has long been unoccupied, and has been fitted up for the ordnance property.

V. Printing, book-binding, drafting, photographing, lithographing, engine driving, repairs of depot buildings and boats, office work, and the general work of keeping property and buildings in a proper state of preservation, has been performed entirely by enlisted men of the engineer battalion, detailed on daily duty and extra duty. The aggregate expense for paying extra duty pay for performing all the above operations amounted, during the fiscal year, to $3,629.48.

DEPOT PROPERTY.

The astronomical, magnetic, meteorological, geodetic, reconnoitering, surveying, and drawing instruments in the depot have been properly cared for, and the following additions have been made during the fiscal year by purchase, viz:

One double reflecting circle, 10 cases drawing instruments, 4 engineer Y levels, 4 engineer transits, with gradienters, 2 sextants, 2 current meters, 12 level rods, 50 Abbot's protractors, 25 prismatic compasses, 25 odometers, 6 binocular field glasses, 16 hand levels, 6 steel chains (100 feet), 6 steel chains (50 feet), six metallic tapes (100 feet), 6 metallic tapes (50 feet), 6 steel tapes (100 feet), 6 steel tapes (50 feet).

All the above instruments are of the latest pattern, and were subject to a thorough examination as to their accuracy and manner of construction before they were accepted and paid for.

The following instruments have been transferred to officers of the Corps of Engineers and to acting engineer officers at division and department headquarters, upon requisitions duly authorized by the Chief of Engineers, U. S. A., viz:

Forty-two Abbot's protractors, 29 odometers, 26 prismatic compasses, 15 compasses, pocket square, 3 theodolites, 3 transit (railroad), 1 engineer level, 2 hand levels, 1 pocket sextant, 2 chronograph *timers*, 2 barometers, mercury cistern, 2 barometer

tripods, 1 case of instruments for repairing barometers, 1 barometer aneroid, 2 level rods, 1 passmeter, 2 spy-glasses, small, 1 case drawing instruments, 4 binocular field glasses, 1 circular protractor, 1 steel chain and pins, 1 chronometer, break circuit, 1 register and paper reel, 1 bridge rheostat, 2 galvanometers.

The following instruments have been received in depot from officers on public works, viz:

Six theodolites, 5 Engineer levels, 4 steel chains (100 feet), 2 silver watches, 2 odometers, 1 plane table, 1 set of pins.

In most cases the above instruments were entirely out of order, and some of them are not worth repairing and will be recommended for inspection and condemnation.

Most of the repairing of the instruments during the year has been done by enlisted men of the engineer battalion, detailed on extra duty as instrument makers, and it is evident that the cost is greatly reduced from what it would have been if the repairs had been made in private shops, while the workmanship has proved in every case to be satisfactory. The cost of extra duty pay for this work amounted during the fiscal year to only $293.50. With about $25 per month nearly all the instruments in the depot have been maintained in good order.

Quite a number of electrical instruments, such as galvanometers, voltmeters, reading telescopes, dynamo machines, dial telegraph instruments, etc., which have been in constant use in electrical and torpedo laboratories, have also been repaired in the depot repair-shop. The necessary tools and materials for repairing all such instruments have been procured, and the repair-shop is now fitted out with a complete set of instrument makers' appliances.

The following instruments have been thoroughly cleaned and repaired during the fiscal year, viz:

Eleven theodolites, 4 railroad transits, 2 aneroid barometers, 4 engineer levels, 3 level rods, 2 cases drawing instruments, 4 odometers, 1 voltmeter, 6 astronomical transits, 1 telescope transit, 11 prismatic compasses, 2 dynamo machines, 4 dial telegraph instruments, 1 reading telescope.

Quite a number of small instruments and others needing slight repairs are not included in this lot.

The following instruments were sent to reputable makers for the purpose of repairing them, but only in such cases when the nature of the repairs required considerable skill—as, for instance, repairing watches, chronometers, or re-graduating instruments—which can only be performed by the best mechanics, viz:

Two theodolites, 4 silver watches, 2 chronographs, 1 case of drawing instruments, and 8 chronometers.

The amount paid for repairing the above instruments was $272.50.

In accordance with my letter published in Circular No. 5, Office of the Chief of Engineers, U. S. Army, Washington, D. C., June 25, 1889, in reference "to certain articles stored in the Engineer Depot and which will hardly be needed again for the purpose originally intended, but which it is thought might be utilized at some other public works now in progress," requisitions were received from different points for articles mentioned in the above circular, and the following have been transferred in the usual manner by exchanging invoices and receipts, viz:

Ninety-six shovels, short and long, shipped to Sandy Hook, N. J.
One hundred and twenty shovels, short and long, shipped to Boston, Mass.
Sixty shovels, short and long, shipped to Buffalo, N. Y.
Two anchors, shipped to Savannah, Ga.
Five anchors, shipped to Nashville, Tenn.
Two anchors, shipped to Wilmington, N. C.

Three anchors, shipped to Cincinnati, Ohio.
One cable chain, shipped to Nashville, Tenn.
Two hundred chess, shipped to West Point, N. Y.
Twenty long balk, shipped to West Point, N. Y.
Four thousand sand bags, shipped to Sandy Hook.

PHOTOGRAPHIC LABORATORY.

Eikonogen, either alone or in conjunction with hydroquinon, was introduced, and after careful experiments and subsequent modifications of prescribed formulas, was found superior to any other substance so far known as a developer of bromide of silver on either plates or paper, and is now worked with perfect success for negatives, dispositions, enlargements, and contact prints.

The value of bromide paper was frequently illustrated by the rapidity and simplicity by which a number of copies, plans, maps, etc., may be obtained independently of daylight.

The magnesium flash-light was found of great advantage for the photographing of interiors, which could not be successfully photographed by any other method.

Numerous plates were made of torpedo explosions, showing by the height and shape of the jets the characteristics of the various explosives employed. Several successful photographs were made of Sims' Fish Torpedo in motion, traveling at a speed of from 18 to 20 miles per hour, showing the position of the float in the water when at a high rate of speed.

Pictorial records were made of several buildings in construction, of the height of the waves at the docks and sea-wall during severe windstorms.

Five hundred lithographic copies, 16 by 20 inches, of a map of Gravolette, were made for Professor Mercur, Military Academy at West Point, N. Y.; 1,250 lithographic copies of new models of torpedoes were printed for the illustration of professional papers written by engineer officers; 300 lithographic copies, 10 by 20 inches, of the Muscle Shoal Canal, Tennessee River, were printed for Colonel Barlow, U. S. Corps of Engineers.

The gelatine dry plate was successfully substituted for the collodion wet plate, which for the making of photo-lithographic transfers had heretofore been used exclusively.

Officers and non-commissioned officers received the prescribed course of instructions, and the line officers availed themselves extensively of the photographic laboratory for instruction and practice.

EXPERIMENTS.

I. *Sims Fish Torpedo.*—The following fish-torpedo runs have been made during the fiscal year ending June 30, 1890, viz:

July 10, 1889.—This run was not successful. The torpedo had not reached the first stake when the coupling in the torpedo burned out; the E. M. F. was about 750 volts at the time. Examination showed the sleeve of the coupling to be loose; but there was apparently no water in the coupling.

July 16, 1889.—Run at 3.20 p. m. before Colonel Mendell. Screw of 36-inch pitch tested. Speed 14.9 miles per hour.

July 30, 1889.—Fish run about 2 p. m. Screw of 30 inches pitch. Captain Roessler took time intervals between buoys with chronograph and chronometer. The torpedo was tracked and its course plotted.

The usual electrical measurements were made. The speed was carefully determined and a result obtained of over 19 miles per hour.

May 2, 1890.—A successful run before some of the delegates to the Pan-American Conference. The torpedo was tracked and its course plotted.

June 10, 1890.—There was a run at about 2 p. m. before the honorable Secretary of War and Chief of Engineers. No record of speed was taken, as there was no attempt to excel the rates already recorded.

It is an important fact developed by the several runs of this torpedo that the new cable is apparently much more durable than either of the former ones tried, no defect whatever having been discovered in it, although it has been used some ten or twelve times with an electromotive force of 1,200 volts and occasionally a current of more than 30 amperes.

* * * * * * *

III. *Torpedo drills.*—Six grand groups of torpedoes were planted from July 1 to September 30, 1889, and during the present season four have been planted by the line officers undergoing instruction at the school. Two officers at a time are detailed for all duties connected with the planting, raising, and cleaning of one grand group, and are furnished with a detachment of non-commissioned officers and privates, the whole under the orders of the senior officers. The *David Bushnell* is this year available for planting mines. The tracking drills, with the search-light, are made as soon as possible after a group has been planted and tested. The Mangin projector, having been received and set up, is used in these drills, and it is noticeably more effective and more easy to manipulate than either of the old search-lights.

IV. *Tests of Explosives.*—Several kinds of explosives were tested by the ordinary pressure-piston method, including dynamite that has been thirteen years in the magazine, Rack-a-rock, and some new compounds that have been so recently invented that they have not received trade names. The dynamite has evidently retained its full vigor. Other results are given in Captain Roessler's reports, which are hereto appended, marked D.

The emmensite, promised last year, has been received and tested, and shows indications of unreliability. Small charges weighed out for testing have been found to partially decompose in a few days, the paper in which they were wrapped acquiring a greasy appearance, and the explosive losing more or less in weight and varying greatly in power.

Quite a number of high explosives have been tested by a new kind of eprouvette, designed to give the relative strength of explosives by a very short and simple process. Plate A.

The charges are carefully weighed out and embedded in dry cement, which acts as a cushion to prevent the disintregation of the metal, which would take place if the explosive came in contact with it. The height to which the projectile is carried can be accurately measured, the point being marked on both guide rods by a small slider of twine. With this apparatus a careful experiment can be made in less than ten minutes, and the results appear to be more uniform and certain than by any other plan I have seen tried. (See Lieutenant Jervey's report, herewith appended, marked E.)

Excluding the larger charges of compressed tonite, which for some reason appears to give discordant results, it will be noticed from the sheet of diagrams, Plate B, that the greatest difference of any result *from the mean is only* about 28.5 per cent. * * *

The explosives tested have in some cases been on hand many years, and the results are not given as a measure of their relative value when freshly made. But to show how they behave after long storage, it is proposed to continue the tests until all the samples on hand have been tried, and such others as promise to give interesting results.

The charge being confined and detonated by a 24-grain fulminate fuze, there can be no doubt as to the complete explosion. The force of the fuze should be subtracted from the result to give the net effect of the explosive, but on the other hand a small amount of work is expended and not registered by the apparatus in compressing the cement. There is also a small amount of leakage around the projectile, but this is nearly checked by the cement, and it is proposed to try a gas-check for the same purpose. This method has a decided advantage over submarine tests, in that the explosive is surrounded with a fairly good non-conductor.

V. *Crater-gauge.*—Some additional experiments were made with the crater-gauge in deep water to ascertain whether the form of crater was much affected by the depth of water below as well as above the charge. It was found that the form of crater is essentially the same in deep water, but that the size gradually diminishes, as was to be expected, with the increased hydrostatic pressure. Of course, if the depth were so great that the fluid pressure of the water became equal to the expansive force of the explosive in its own volume, no enlargement of that volume would take place.

The frame was also placed in a horizontal position, so as to get a horizontal section of the crater, and this was found to be approximately circular, although the experiments were interrupted by cold weather before a sufficient number had been made to justify any definite conclusion.

In order to give this method a still more thorough trial, some special spherical cases for holding the charges have been made, and the frame has been enlarged so as to allow heavier charges to be tried.

When these additional experiments have been made a discussion of the form and size of crater for different charges will be undertaken, and the results as compared and checked by the pressure-indicator described in last report will, it is hoped, throw some additional light on the phenomena of submarine explosions.

VI. *Sensitiveness of explosives.*—Experiments were made to determine the relative sensitiveness of explosives to percussion. It has been found that the direction of the blow as well as its force must be taken into account. For this purpose a simple apparatus was made, consisting of a blacksmith's anvil, a striking hammer, weighing with its attachments about 15 pounds, with arms to guide and direct the blow. By shifting the pin at the top the blow may be varied from one almost direct to one nearly parallel with the face of the anvil, thus introducing an exact and measurable glance. The force of the blow is measured with a scale which gives the vertical fall of the hammer. The great range of sensitiveness is apparent from the fact that a fall of one-eighth of an inch will explode some compounds, while a fall of 14 inches is required to explode others. Of course in a matter of this kind nothing but a large number of careful experiments with each explosive can be relied on, and such a series of experiments is now being made by Lieutenant Harding and Sergeant Brown.

Out of fifty compounds tried thus far, mercuric fulminate appears to be most sensitive, while explosive gelatine, several years old, is but little behind it. The picrates rank high for stability, designolle requiring a drop of 14 inches to explode it.

A few grains of the explosive are weighed out and carefully spread upon the smooth face of the anvil. The hammer is then lowered upon it to insure a good contact, and is then dropped from various heights, gradually increasing until an explosion takes place. This operation is then repeated until it is ascertained just what fall is required to produce an explosion with a given explosive.

The great importance of stability against shocks, compression, and other accidental causes of explosion is recognized by all, and in order to develop some standard test the apparatus shown on plate C was devised.

The object in view was to apply an accurate and measureable blow in a glancing direction so that each sample of explosive could be treated in exactly the same way. The report of Lieutenant Harding, U. S. Engineers, who made most of the tests with this apparatus, is appended, marked F

Although inventors often claim that a bullet may be fired through their explosives without igniting it, the results and tests applied to over fifty explosives show that such statements must be taken with great caution.

It is also to be noted that an explosive may be quite stable when freshly made and yet become very sensitive after long storage. Most nitro-glycerine compounds appear liable to become as sensitive as nitro-glycerine itself, as might be expected from the exudation of that substance.

* * * * * *

IX. *Tests of insulated cable.*—During the year tests have been made of the several sample cables stored in tanks, and of some new kinds of insulation, including the Cobb vulcanite and the seamless rubber insulation. The results were recorded for comparison with those already recorded and those hereafter to be obtained. Captain Roessler's report, herewith appended, marked H.

X. *Self-acting mine.*—Further trials have been made with the self-acting mine, and they will be continued and made the subject of a special report.

XI. *Building materials.*—Lieutenant D'Armit, U. S. Engineers, has made a number of tests of building stones, bricks, and cement. The results of testing several varieties of stone and of a new and remarkably strong kind of brick are appended, marked I.

This brick, it will be seen, has three times the strength of ordinary brick to resist crushing, and its absorptive power is less than that of many kinds of sandstone. It was tested at the suggestion of Colonel Barlow, U. S. Engineers, with the view to its use for lock masonry in places where stone are scarce.

STATEMENT OF FUNDS.

I. *Engineer Depot at Willets Point, New York.*—Congress appropriated for the fiscal year ending June 30, 1890:

1. For incidental expenses of depot (incidentals)	$5,000.00
2. For instruction of battalion (materials)	1,500.00
3. For purchase and repair of instruments (instruments)	4,000.00
4. For purchase and binding of professional works of recent date on military and civil engineering (library)	500.00
5. For a new building to contain engineer models (building for models)	8,000.00
Total	19,000.00

Of this there has been expended and pledged:

1. For incidental expenses of depot (incidentals)	$5,000.00
2. For instruction of battalion (materials)	1,500.00
3. For purchase and repair of instruments (instruments)	4,000.00
4. For purchase and binding of professional works of recent date on military and civil engineering (library)	500.00
5. For a new building to contain engineer models (building for models)	4,970.37
Total	15,970.37

General Orders No. 69, 1890, headquarters of the Army, A. G. O., June 27, 1890, publish an act of Congress which provides as follows:

That the appropriation of $8.000 for an engineer museum at Willets Point, New York, in act of March 2, 1889, be, and the same is hereby, continued in force for one year (*i. e.*, June 30, 1891).

II. *Torpedoes for harbor defense* (*act September* 22,1888).—The expenditure of the following items of the $200,000 appropriated by act of Congress September 22, 1888, has been assigned to me for disbursement, and is available until expended, viz:

1. For purchase of a complete electric-light outfit	$10,000.00
2. For purchase of submarine mining material	58,000.00
3. For continuing torpedo experiments	15,000.00
4. For instruction of engineer troops in submarine mining	10,000.00
5. For purchase of motors for equipping movable torpedoes	5,000.00
Total	98,000.00

Of this there has been expended and pledged—

1. For purchase of a complete electric-light outfit	3,256.18
2. For purchase of submarine mining material	57,533.32
3. For continuing torpedo experiments	6,675.57
4. For instruction of engineer troops in submarine mining	6,192.66
5. For purchase of motors for equipping movable torpedoes	
Total	73,657.73

III. *Torpedoes for harbor defense* (*act March* 2, 1889).—The act of Congress making appropriations for fortifications, ordnance, etc., approved March 2, 1889, appropriates under the general title, "Torpedoes for harbor defense," the sum of $250,000 for the purchase of submarine mines and necessary appliances to operate them for closing the channels leading to our principal sea-ports.

The Board of Ordnance and Fortification has approved the expenditure of the appropriation above mentioned, based upon the project of the Board of Engineers. The expenditure has been authorized by the honorable Secretary of War, placed in my charge, and is available until expended, viz:

Submarine mines and necessary appliances.

1. For purchase of material for storage at Boston	$33,256.00
2. For purchase of material for storage at New York	131,180.00
3. For purchase of material for storage at San Francisco	60,541.00
4. For insulated core to be stored at Willets Point	20,500.00
5. To contingent balance, to be expended in No. 32 B torpedoes	4,523.00

Under the same act the following appropriation for "continuing torpedo experiments and for practical instruction of engineer troops in the details of the service" was placed in my charge and is available until expended, viz:

6. For torpedo experiments and instruction of engineer troops in submarine mining	30,000.00

Congress appropriated by act of March 2, 1889, under the general title "Torpedoes for harbor defense," the sum of $50,000 for purchase of movable submarine torpedoes. The Board of Ordnance and Fortification has approved an allotment of the above, and the allotment has been authorized by the honorable Secretary of War under date of May 5, 1890, and placed in my charge, and is available until expended, viz:

7. For purchase of movable submarine torpedoes	$25,225.00
Total	305,225.00

Of this there has been expended and pledged:

1. For purchase of material for storage at Boston	26,343.18
2. For purchase of material for storage at New York	92,629.10
3. For purchase of material for storage at San Francisco	48,639.20
Total	167,611.48

IV. *New appropriations.*—General Orders No. 69, Headquarters of the Army, Adjutant General's Office, June 27, 1890, publish the act of Congress making appropriations for the support of the Army for the fiscal year ending June 30, 1891, and for other purposes.

The following items are designated for the Engineer Department, and assigned to me for disbursement, viz:

Engineer depot at Willets Point, New York:

1. For incidental expenses of depot (incidentals)	$5,000
2. For instruction of battalion (materials)	1,500
3. For purchase and repair of instruments (instruments)	2,500
4. For purchase and binding of professional works of recent date, on military and civil engineering (library)	500
Total	9,500

And that the appropriation of $8,000 for an engineer museum at Willets Point, N. Y., approved in act of March 2, 1889, be, and the same is hereby, continued in force for one year (extended to June 30, 1891).

ESTIMATES.

Engineer depot at Willets Point, New York.—There will be required for the fiscal year ending June 30, 1892, the following, viz:

I. For incidental expenses of depot, including fuel, lights, chemicals, stationery, hardware, extra duty pay to soldiers necessarily employed as artificers, on work in addition to, and not strictly in the line of their military duties, such as carpenters, clerks, blacksmiths, draughtsmen, printers, bookbinders, lithographers, engine drivers, teamsters, wheelwrights, masons, machinists, painters, overseers, laborers, and clerk hire, and for materials to repair public buildings, machinery, and unforeseen expenses	$5,000
II. For purchase of materials for the instruction of engineer troops in their special duties as sappers and miners, and pontoniers	4,500
III. For purchase and repair of instruments to be issued to officers of the Corps of Engineers and to Acting Engineer officers for use on public works and surveys	2,500
IV. For the library of the United States Engineer School, purchase and binding of professional works of recent date, treating of military and civil engineering, and kindred scientific subjects	500
V. For a fire-proof building to replace engineer store-house, which was destroyed by fire on May 10, 1890; for storing intrenching tools, bridge equipage, ponton materials, and general stores	16,000
Total	28,500

Very respectfully, your obedient servant,

W. R. KING,
Lieutenant-Colonel of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

APPENDIX A.—PROGRAMME OF STUDY AND INSTRUCTION FOR SUMMER SEASON.

[Printed Orders No. 77.]

UNITED STATES ENGINEER SCHOOL,
Post of Willets Point, New York Harbor, April 22, 1889.

The following programme of study and instruction for the ensuing summer season, to commence May 6 and end November 16, 1889 (twenty-eight weeks), having been recommended by the academic staff and approved by the Chief of Engineers, will be carried into effect.

MILITARY ENGINEERING.

(1) Instruction by the company officers in the nomenclature, dimensions, and construction of modern siege batteries and saps. (2) A full course of trestle and ponton drill. (3) Instruction in military mining. (4) Military map-making in accordance with existing orders and instructions. Each lieutenant who has not already done so, and such non-commissioned officers and privates as may be selected from each company, will make satisfactory foot reconnaissance about 4 miles long, in the vicinity of the post, the maps thereof to be submitted by company commanders to post headquarters on or before the termination of the season.

TORPEDO DRILLS.

After receiving such preliminary practice as may be necessary to acquaint them with the practical details of preparing and planting a torpedo, the officers of the torpedo class will be divided into details of at least two officers each, for the purpose of taking charge of the preparation and planting of a grand group of torpedoes. The senior officer will be in general charge, and will keep a daily journal of operations, noting particularly any difficulties encountered and any suggestions that may occur to him looking to the avoidance of similar difficulties in the future. The officers will frequently interchange duties, so that each one shall have some experience in each part of the drill. The electric light will be set up and operated. The grand group being completed and the search-light in position, the post commander will order an exhibition drill illustrating the operations of the torpedo defense against an attempted passage of the mine field by an enemy's vessel under cover of night. The group will then be taken up by the same detail and the parts dismantled, cleaned, and conveniently grouped for the inspection of the instructor. The detail will be instructed and exercised in automatic and judgment-firing drills at such times as may be most convenient before the final exhibition drill.

If boat facilities can be provided, two grand group drills will be carried on at the same time.

The detail of enlisted men for each grand group drill will consist of three non-commissioned officers and about twelve privates. The hours of work will be from 7 to 11.30 a. m., and from 1 to 5 p. m. Both officers and enlisted men will be excused from all other military duties while actively engaged on this work. In bad weather when no work is done and the men are in barracks, the latter will attend the same company duties and roll-calls as daily-duty men.

Weekly reports of progress will be rendered by the senior officer of the detail, and at the conclusion of the work each officer will submit a report of the work done by him, mentioning difficulties encountered and any suggestions he may desire to make. A detailed record will be kept of what each man does with the view of tracing out the author of defective work and determining the degree of proficiency developed by individual members of the detail. An account of the character of work done by each man will be submitted by the senior officer with his final report. Upon completion of the drill such men of the detail as shall have shown themselves efficient and deserving, will, if practicable, receive furloughs of two days.

Occasionally, loaded mines will be planted and fired as in actual service. Height of jet, effect on neighboring mines, and other phenomena being carefully observed and recorded.

Experiments will be made with the self-acting mine at such times as will not interfere with the grand group practice.

The details of officers will be made, as far as practicable, from the artillery and infantry officers until the 1st of July.

CIVIL ENGINEERING.

The following instrumental surveys will begin as soon as practicable, and officers when detailed for this purpose will be excused from all other duty *when actually engaged in the field work.* Each lieutenant who has not already done so, will make and

plot a careful instrumental survey of about 1 square mile of ground. The work will include contours with a surveyor's level. He will be assisted in the field work by details of non-commissioned officers and privates from his company. The work will be plotted on a scale of 12 inches to the mile, with contour planes 10 feet apart. Good level bench marks should be made and located on the map, the references being given a column of notes. The names of the residents should be recorded. A field azimuth of one of the lines will be determined astronomically. The finished maps will be submitted on or before the termination of the season.

A careful hydrographic survey of about one-quarter of a square mile, including current measurements with electric current meter and double floats will be made, if practicable, by the lieutenants who have not already done so.

FIELD ASTRONOMY.

All the lieutenants who have not already completed the course, and been excused from further observations, will constitute the observers, being called upon by the officer in charge as wanted. In addition, when officer of the day (except on Sundays), the weather permitting, they will observe the sun for time.

The following system will govern the observations at the observatory. The course covers two seasons—the first including sextant work, and transit and zenith telescope work, with the instruments in the east wing and on the outer pier; and the second including sextant work, practice with the new combined instruments in the west wing. Officers wishing to use the instruments for special observations or practice, must apply for authority to do so.

Suitable blank forms will be provided, both for observations and computations; and these original records after inspection by the commanding officer will be returned to the officers as their personal property.

The following allowance of time will be made for computations: Three days for a set of latitude observations with the sextant, for a set of time observations with the transit, for the value of a level division or for a micrometer turn with the zenith telescope, and ten days for latitude, by the zenith telescope.

The following will be the ordinary routine of observations with the several instruments:

Sextant.—After becoming skillful in the use of this instrument upon the sun, observers will deduce at least one satisfactory latitude by observing a north and a south star, using the time deduced from an east and a west star—each based on ten altitudes taken on the same night. These observations for latitude and time must be made at the observatory, and the time results must be reported for the Lukens' chronometer. *No other record will be accepted.*

Transit.—A satisfactory set of time observations will be taken by each officer on two nights, successive if possible, the observer taking his own time.

Zenith telescope.—Observers will first determine the level correction by daylight, using a distant terrestrial object, or at night using a slow circumpolar star. They will then find the value of a turn of the micrometer by observing Polaris at elongation. Lastly, they will observe for latitude, until they have obtained a satisfactory determination based on three nights' work upon not less than twenty pairs.

Astronomical azimuth.—Each officer serving his second year will determine an astronomical azimuth—using a large theodolite for the purpose.

Each officer shall receive instruction in the use of the personal equation machine and chronograph, and in comparison of chronometers.

MILITARY PHOTOGRAPHY.

The officers' laboratory will be open daily from 1.30 p. m. until 4 p. m. The building, apparatus, chemicals, etc., will be under the charge of the battalion quartermaster, whose duty it is to furnish any desired assistance, and who will be held responsible for the judicious use of the property. Officers are invited to avail themselves of the advantages of the laboratory, making such arrangements with the officer in charge as shall insure no confusion in his official duties, or in those of the men under his instruction. The instruction of enlisted men will be restricted to a weekly detail of one non-commissioned officer from each company. The battalion quartermaster will submit to this office weekly reports showing the *nature of the instruction given*, the results attained, and the progress made.

By order of Lieutenant-Colonel King:

J. G. WARREN,
First Lieut. of Engineers, Post Adjutant.

APPENDIX B.—PROGRAMME OF STUDY AND INSTRUCTION FOR WINTER SEASON.

[Printed Orders, No. 232.]

UNITED STATES ENGINEER SCHOOL,
Post of Willets Point, New York Harbor, November 14, 1889.

I. The following programme of study and instructions for the ensuing winter season, commencing Monday, December 2, 1889, and ending April 26, 1890 (a period of twenty-one weeks), having been recommended by the academic staff and approved by the Chief of Engineers, will be carried into effect.

COURSE FOR OFFICERS.

1. Examinations by the academic staff will be held at the end of January and April, and intermediate examinations, as nearly monthly as practicable, will be held by committees of the academic staff. Marks at examinations will be on the West Point system, and the committees will report to the commandant of the school the results of the examinations. As the efficiency of the instruction can be much influenced by the instructors, they will keep themselves fully advised of the progress of the students; will give them at any time any needed aid, and when the information on special subjects is difficult to obtain, should supplement the course by lectures. The instructors will meet their classes weekly, and assign the lessons for the following week.

FIRST WINTER'S COURSE.

2. The course for Engineer officers spending their first winter at the school will be: Electricity and torpedoes, nineteen weeks; surveying, two weeks. For officers of other arms of the service detailed for special instruction in the torpedo service: Electricity and torpedoes, twenty-one weeks.

ELECTRICITY.

3. Study of, in its application to torpedo warfare, arc and incandescent lighting, and transmission of power, supplemented by extensive laboratory practice in the solution of the special problems involved. Text-books and books of reference, as follows: Abbot's Notes on Electricity; Ayrton's Practical Electricity; Thompson's Electricity and Magnetism; Maier's Arc and Glow Lamps; Swinburne's Practical Electrical Measurements; Kapp's Electrical Transmission of Energy; Part II of Professional Papers No. 23, Corps of Engineers, U. S. A.; Gray's Absolute Measurements, Volume II; Monroe and Jamieson's Pocket Book of Electrical Rules and Tables.

TORPEDOES.

4. Text-book: The Torpedo Manual. Practice will be had in making all the adjustments and tests required in planting and operating torpedoes, the operations on the water being simulated as far as practicable by special indoor appliances. Books of reference: Bucknill's Submarine Mines and Torpedoes as applied to Harbor Defense; Scheidnagle's Treatise upon Defensive Submarine Mining.

5. Attendance at the electrical laboratory will be regulated by the instructor. Theoretical study will be done as far as practicable in quarters. All laboratory work will be done without the use of text-books or text-book diagrams. Officers may, however, use manuscript notes or diagrams prepared before going to the laboratory. Laboratory practice will be had from 8 a. m. to 12 m., and from 1 to 5 p. m. During the last two weeks of the course each officer will prepare a plan (map and memoir) for the defense of such harbor as may be designated by the instructor, special attention being given to the torpedo defense and the batteries protecting the torpedo lines.

SURVEYING.

6. (Last two weeks of course and preparatory to actual field-work). Subjects: (1) Adjustment, use, and care of instruments; (2) topographical surveying with transit and stadia; (3) hydrographic surveying and gauging of rivers; (4) geodetic surveying. Text-book: Such parts as may be designated by the academic staff, of Johnson's Theory and Practice of Surveying.

SECOND WINTER'S COURSE.

7. Civil engineering, five weeks; military engineering, seven weeks; photography, five weeks; torpedoes, four weeks.

CIVIL ENGINEERING.

8. Five weeks. Subjects: (1) Improvement of non-tidal rivers; (2) improvement of tidal rivers: (3) canals.

9. Text-books: Vernons Harcourt's Rivers and Canals; Schlichting's Improvement of non-tidal Rivers. Books of reference (see third winter's course).

MILITARY ENGINEERING.

10. Seven weeks. Subjects: (1) Modern guns, carriages, and projectiles; (2) steel, compound, wrought, and cast-iron armor; (3) modern ships of war and sea-coast defenses; (4) modern fortifications, and their attack and defense.

11. Text-books: Such parts of the following books as may be designated by the academic staff: Woolwich Text-Book of Fortifications; Maguire's Attack and Defense of Coast Fortifications; Fortifications of To-day; Inglis' paper in Professional Papers Royal Engineers, 1884, and a lecture on armored defense in Ordnance Notes No. 151; Very's Development of Armor; Naval Intelligence Papers, June, 1886; Adam's Spezia's Experiments, 1886; Baylay's Types of Modern Guns; the protection of Heavy Guns for Coast Defense, Sir A. Clark; Abbot's Lectures on Sea-Coast Defense.

12. Books of reference: Articles on Fortification and Gunnery, Encyclopedia Britannica; Ordnance Notes, No. 135 and Appendix; Volume 9, Professional Papers Royal Engineers; Report Board on Fortifications; Text Books on Gunnery, McKinlay; Naval Annual, 1887, Brassy.

MILITARY PHOTOGRAPHY.

13. Five weeks. Practice will be had in the following methods: Negatives by wet and dry processes; developers and intensifiers; silver printing, and finishing and mounting of prints; map printing; photo-lithography, including the negative and transfer to stone and printing. Each officer to submit 12 printed copies of his map. Text books: Griffin's Notes on Photography; von Sothen's The Development of the Latent Image on Gelatino-Bromide of Silver.

TORPEDOES.

14. Four weeks. One or more officers of the second and third winter's course will be detailed weekly to report to the instructor in torpedoes, as assistant for testing core joints and instructing enlisted men on the torpedo detail.

THIRD WINTER'S COURSE.

15. Civil engineering, ten weeks; military engineering, six weeks; torpedoes, five weeks.

CIVIL ENGINEERING.

16. Ten weeks. Subjects: (1) Wave and current action, and improvement of harbors. (2) Steam engines and pumps. (3) Building superintendence. (4) Preparation of project for, or the history of the improvement of some designated river or harbor.

17. Text books: Such parts of the following books as may be designated by the academic staff: Vernon Harcourt's Harbors and Docks; Edward's Steam Engineer's Guide; Clark's Building Superintendence.

18. Books of reference: Rankine's Civil Engineering and Steam Engine; Bixby's Pointe de Grave; articles on Hydro-Mechanics and Steam Engine, in Encyclopedia Britannica; Cotterill's Applied Mechanics; Jameison on Steam Engine; Steam Boilers, Wilson; Modern Steam Engine, Rose; Canal and River Engineering, D. Stevenson; Construction of Harbor, T. Stevenson; Trautwine's Engineers' Pocket Book; Berg's Safe Building; Billing's Ventilation and Heating.

MILITARY ENGINEERING.

19. Six weeks. Hamley's Operations of War, and preparation of project for the defense of such place as may be designated by the instructor.

TORPEDOES.

20. Five weeks. See paragraph on torpedoes in second winter's course.

COURSE FOR ENLISTED MEN.

INSTRUCTION OF ENLISTED MEN IN TORPEDOES.

21. Instruction will comprise telegraphing with the dial instrument, including the code for action, and practice in the Morse system of telegraphy; the duties of the loading room, and, so far as practicable, of the boat service as prescribed in the torpe. o manual, comprising preparing the plugs of the buoyant and ground torpedoes; charging the mines; charging the cut-off boxes, three methods: joining the cores; making turk's heads in the electrical cable; using the junction boxes; attaching a cable stop; splicing and knotting hemp rope; inserting thimble in wire mooring rope. They will also receive from the instructor in torpedoes, or his assistant, lectures respecting the fuzes, explosives, torpedo material (except that of the operating room), voltaic batteries, simple electrical testing, and the use of the portable apparatus for the electrical ignition of mines

The "unit" detail for this instruction will consist of 1 non-commissioned officer and 4 privates. Six such details will report for duty Monday morning and will continue their instruction during fatigue hours until their work has been inspected and accepted by the officer in immediate charge. One or two of the unit details will probably finish their tasks by Tuesday evening, when other details may be made to commence work Wednesday morning. As soon as a man has had his work accepted, *i. e.*, has received a rating of "2.5" he will be excused from further attendance, and in case he has shown a commendable amount of skill and intelligence in his duties, will be a condidate for such special privileges as it may be deemed expedient to give him. A soldier qualifying twice as "2.5" will be excused from further detail during the winter season.

Recruits on their first detail will be kept under instruction indefinitely until they have done each task at least twice and have received a rating of at least "2.0". They will then be placed on the same footing as old soldiers for further details.

The officer in immediate charge will be present in the loading rooms a large portion of each day, frequently inspecting the work of the several details. He will make it special object to note the character of the instructions given by the non-commissioned officers who should know their duties well, and who should be held to a strict account for any defective work that their details may do. He will rate the men as they complete their tasks by a detailed examination of their finished work and a more or less detailed course of questioning. In determining a man's "mark" regard will be had to the degree of intelligence displayed, as well as to the mechanical skill with which the work has been done. At the close of each week he will submit a "proficiency" report of the detail, and state what verbal or other instruction was given during the week.

INSTRUCTION OF ENLISTED MEN IN PHOTOGRAPHY.

22. Two non-commissioned officers will be detailed each week for instruction in map printing.

II. The following assignment of instructions is made:

Military Engineering: Capt. R. L. Hoxie, Corps of Engineers.
Civil engineering: Capt. E. Bergland, Corps of Engineers.
Torpedoes: Capt. S. W. Roessler, Corps of Engineers.
Military Photography; The Battalion Quartermaster.

By order of Lieutenant-Colonel King:

F. R. SHUNK,
Second Lieut. of Engineers, Acting Post Adjutant.

APPENDIX C.—PROGRAMME OF STUDY AND INSTRUCTION FOR SUMMER SEASON.

[Printed Orders No. 81.]

UNITED STATES ENGINEER SCHOOL,
POST OF WILLETS POINT, NEW YORK HARBOR,
April 26, 1890.

The following programme of study and instruction for the ensuing summer season, to commence May 5, and end November 15, 1890 (twenty-eight weeks), having been recommended by the academic staff, and approved by the Chief of Engineers, will be carried into effect.

MILITARY ENGINEERING.

1st. Instruction by the company officers in the nomenclature, dimensions, and construction of modern siege batteries and saps. 2d. A full course of trestle and ponton drill. 3d. Instruction in military mining. 4th. Military map making in accordance with existing orders and instructions. Each lieutenant who has not already done so, and such non-commissioned officers and privates as may be selected from each company will make satisfactory foot reconnaissances about 4 miles long in the vicinity of the post, the maps thereof to be submitted by company commanders to post headquarters on or before the termination of the season.

TORPEDO DRILLS.

After receiving such preliminary practice as may be necessary to acquaint them with the practical details of preparing and planting a torpedo, the officers of the torpedo class will be divided into details of at least two officers each, for the purpose of taking charge of the preparation and planting of a grand group of torpedoes. The senior officer will be in general charge, and will keep a daily journal of operations, noting particularly any difficulties encountered and any suggestions that may occur to him looking to the avoidance of similar difficulties in the future. The officers will frequently interchange duties, so that each one shall have some experience in each part of the drill. The electric light will be set up and operated. The grand group being completed, and the search light in position, the post commander will order an exhibition drill illustrating the operations of the torpedo defense, against an attempted passage of the mine field by an enemy's vessel under cover of night. The group will then be taken up by the same detail, and the parts dismantled, cleaned, and conveniently grouped for the inspection of the instructor.

The detail will be instructed and exercised in automatic and judgment firing drills at such times as may be most convenient before the final exhibition drill. The detail of enlisted men for each grand group drill will consist of three non-commissioned officers and about twelve privates. The hours of work will be from 7 to 11:30 a. m., and from 1 to 4:30 p. m. Both officers and enlisted men will be excused from all other military duties while actively engaged on this work. In bad weather when no work is done and the men are in barracks, the latter will attend the same company duties and roll-calls as daily duty men.

Weekly reports of progress will be rendered by the senior officer of the detail, and at the conclusion of the work each officer will submit a report of the work done by him, mentioning difficulties encountered and any suggestions he may desire to make. A detailed record will be kept of what each man does with the view of tracing out the author of defective work and determining the degree of proficiency developed by individual members of the detail. An account of the character of work done by each man will be submitted by the senior officer with his final report. Occasionally, loaded mines will be planted and fired as in actual service, height of jet, effect on neighboring mines and other phenomena being carefully observed and recorded.

At such times as will not interfere with the drills above mentioned, the officers of the class will make practical experiments in calibrating commercial ammeters and voltmeters, testing efficiency of dynamos and motors, and putting up an incandescent light installation.

CIVIL ENGINEERING.

The following instrumental surveys will begin as soon as practicable, and officers when detailed for this purpose will be excused from all other duty when actually engaged in the field work. Each lieutenant, who has not already done so, will make and plot a careful instrumental survey of about one square mile of ground. The work will include contours with a surveyor's level. He will be assisted in the field work by details of non-commissioned officers and privates from his company. The work will be plotted on a scale of 12 inches to the mile with contour planes 10 feet apart. Good level bench-marks should be made and located on the map, the references being given a column of notes. The names of the residents should be recorded on map. A field azimuth of one of the lines will be determined astronomically. The finished maps will be submitted on or before the termination of the season.

A careful hydrographic survey of about one quarter ($\frac{1}{4}$) of a square mile, including current measurements with electric current meter and double floats will be made, if practicable, by the lieutenants who have not already done so.

FIELD ASTRONOMY.

All the lieutenants who have not already completed the course, and been excused from further observations, will constitute the observers, being called upon by the

officer in charge as wanted. In addition, when officer of the day (except on Sundays), the weather permitting, they will observe the sun for time.

The following system will govern the observations at the observatory. The course covers two seasons—the first including sextant work, and transit and zenith telescope work, with the instruments in the east wing and on the outer pier; and the second including sextant work, practice with the new combined instruments in the west wing. Officers wishing to use the instruments for special observations of practice, must apply for authority to do so. In case of damage to instruments or apparatus, it will be promptly reported to the instructor for the action of a board of survey.

Suitable blank forms will be provided, both for observations and computations; and these original records, after inspection by the commanding officer, will be returned to the officers as their personal property.

The following allowance of time will be made for computations: Three days for a set of latitude observations with the sextant, for a set of time observations with the transit, for the value of a level division or for a micrometer turn with the zenith telescope, and ten days for latitude by the zenith telescope.

The following will be the ordinary routine of observations with the several instruments.

Sextant.—After becoming skillful in the use of this instrument upon the sun, observers will deduce at least one satisfactory latitude by observing a north and a south star, using the time deduced from an east and a west star—each based on ten altitudes taken on the same night. These observations for latitude and time must be made at the observatory, and the time results must be reported for the Luken's chronometer. *No other record will be accepted.*

Transit.—A satisfactory set of time observations will be taken by each officer on two nights, successive if possible, the observer taking his own time.

Zenith telescope.—Observers will first determine the level correction by daylight, using a distant terrestrial object, or at night using a slow circumpolar star. They will then find the value of a turn of the micrometer by observing Polaris at elongation. Lastly, they will observe for latitude, until they have obtained a satisfactory determination based on three nights' work upon not less than twenty pairs.

Astronomical Azimuth.—Each officer serving his second year will determine an astronomical azimuth—using a large theodolite for the purpose.

Each officer shall receive instruction in the use of the personal equation machine and chronograph, and in comparison of chronometers.

MILITARY PHOTOGRAPHY.

The officers' laboratory will be open daily from 1.30 p. m. until 4 p. m. The building, apparatus, chemicals, etc., will be under the charge of the battalion quartermaster, whose duty it is to furnish any desired assistance, and who will be held responsible for the judicious use of the property. Officers are invited to avail themselves of the advantages of the laboratory, making such arrangements with the officer in charge as shall insure no confusion in his official duties, or in those of the men under his instruction. The instruction of enlisted men will be restricted to a weekly detail of one non-commissioned officer from each company. The battalion quartermaster will submit to this office weekly reports showing the *nature of the instruction given*, the results attained, and the progress made.

By order of Lieutenant-Colonel King.

J. G. WARREN,
First Lieutenant of Engineers, Post Adjutant.

APPENDIX D.—RING-FIRING EXPERIMENTS WITH A NEW EXPLOSIVE INVENTED BY COLONEL ALEXANDER, OF WASHINGTON, D. C.

REPORTS OF CAPTAIN SOLOMON W. ROESSLER, CORPS OF ENGINEERS.

1.

WILLETS POINT, NEW YORK HARBOR, *April* 10, 1890.

The experiments were made with the 4-foot ring, using No. 1 gauge and 0.4-inch lead cylinders.

The samples tested were manufactured at Willets Point two days before the test. At the request of the inventor no reference is made to the ingredients used or the mode of manufacture. The composition has not yet been given a trade name.

Three charges were fired of 3 pounds each. The details of the shots and the pressures recorded on the lead cylinders are given in the sheets hereto appended, marked A and B.

The inventor called his composition *rifle powder*, but it was evident from the character of the explosions that we were not dealing with any slow-burning composition,

but with a high explosive of considerable strength. The following equations, applicable to subaqueous explosions, result from the three experiments made:

$$K = 44.8 \quad \ldots \quad (1)$$

$$E = 123 \quad \ldots \quad (2)$$

$$W = \frac{44.8\,C}{(D+0.01)^{2.1}} \quad \ldots \quad (3)$$

$$P = \sqrt[3]{\left[\frac{1415000\,C}{(D+0.01)^{2.1}}\right]^2} \quad \ldots \quad (4)$$

$$P = \sqrt[3]{\left[\frac{6636(\vartheta+123)\,C}{[D+0.01]^{2.1}}\right]^2} \quad \ldots \quad (5)$$

in which K and E are constants depending on the nature of the explosive; C, the weight of the charge in pounds; D, distance in feet from the center of the charge to the surface exposed to the shock; W, foot-pounds energy per square inch of surface exposed to the shock; ϑ, the angular distance in degrees of arc measured from the nadir to the point where the pressure is considered. Equations (3) and (4) apply to points in the horizontal plane through the center of the charge; equation (5) applies to points in the vertical plane through the center of the charge.

Comparing equation (5) with that for dynamite No. 1 (75 per cent. nitro glycerine) I find the new explosive to have a strength equal to 84 per cent. that of the latter.

The above equations being based upon so small a number of experiments and upon a sample which was manufactured with imperfect appliances, should be regarded as subject to verification by future experiments.

The powder was further tested as to the smoke element, the inventor claiming that when fired from a musket it gave off much less smoke than the ordinary black powder. A number of service shells were loaded with charges of 25, 30, and 35 grains powder and 500-grain bullet, and fired into a target made of white pine boards placed parallel to each other and held about an inch apart by strips at each end. The results were briefly as follows:

1. The penetration of the 35-grain charge was nearly equal to that of the service ammunition.

2. The 35-grain charge gave off less smoke than the service ammunition, but no very decided merit as to smokelessness was developed. In reference to this point it is proper to mention that the powder had not been dried, and it may be that the considerable amount of moisture which the charge probably contained when developed into vapor tended to increase the apparent density of the smoke.

A second composition, called by Colonel Alexander his *high* explosive, was submitted for experiment and subjected to the following tests:

Shot No. 1. Three pounds explosive in tin can, ignited by one 24-grain fulminating fuze. Submergence, 35 feet. No explosion.

Shot No. 2. Same as No. 1. No explosion.

Shot No. 3. One pound explosive ignited by 1 ounce gun-cotton and 1 24-grain fulminating fuze. Submergence, 2 feet. No explosion.

Shot No. 4. One pound explosive ignited by 30 grains musket powder and one 24-grain fulminating fuze. No explosion.

S. W. ROESSLER,
Captain of Engineers.

A.—*Shot No.* 1, *April* 8, 1890.

Details of experiment.	Gauge.		Lead cylinder.		Per square inch.	
	Kind.	No.	Diameter.	Shortening.	Energy.	Pressure.
			Inches.	*Inches.*	*Foot pounds*	*Pounds.*
Explosive, Colonel Alexander's rifle powder; ring, 4 feet; charge 3 pounds; submergence 30 feet case, can No.—saw-dust tamping; ignition, Smith's exploder, one low tension fuze; effects, one safety-line shackle broken.	1	1	0.4	.190	74.30	17,660
	1	2	0.4	.171	63.70	15,940
	1	3	0.4	.114	34.40	10,570
	1	4	0.4	.123	39.50	11,500
	1	5	0.4	.131	43.30	12,300
	1	6	0.4	.117	36.80	11,060
Mean						13,190

Shot No. 2, April 8, 1890.

Details of experiment.	Gauge.		Lead cylinder.		Per square inch.	
	Kind.	No.	Diameter.	Shortening.	Energy.	Pressure.
			Inches.	*Inches.*	*Foot pounds*	*Pounds.*
Explosive, Colonel Alexander's rifle powder; all conditions same as in shot No. 1. Effects: Ring cracked in two points, one gauge broken. Pressure for gauge No. 2 assumed to be same as that for No. 1.	1	1	0.4	.173	64.8	16,120
	1	2	0.4	(*)	(*)	(*)
	1	3	0.4	.101	29.9	9,630
	1	4	0.4	.114	35.4	10,770
	1	5	0.4	.096	27.9	9,190
	1	6	0.4	.123	39.5	11,590
Mean						12,237

*Lost.

B.—*Shot No. 3, April 8, 1890.*

Explosive, Colonel Alexander's rifle powder. Conditions all same as in shot No. 1. Effects normal.	1	1	0.4	.146	50.6	13,670
	1	2	0.4	.165	60.5	15,400
	1	3	0.4	.111	34.1	9,730
	1	4	0.4	.119	37.6	11,220
	1	5	0.4	.125	40.5	11,790
	1	6	0.4	.109	33.2	9,560
Mean						11,895

2.

TORPEDO DEPARTMENT,
Willets Point, New York Harbor, April 18, 1890.

SIR: I have the honor to submit the following report of ring-firing experiments made during the present week to determine the strength of a new high explosive invented by Mr. S. R. Divine, chemist to the Rendrock Powder Company.

The explosive was invented during the past winter and has been under laboratory test for about two months. Its composition is as yet a trade secret.

The experiments were made with the usual apparatus and are recorded in detail in the appendix. Fifteen shots were fired, five shots of 2 pounds each and ten shots of 1 pound each. Two of the latter failed to explode, probably on account of leakage of water into the tin case containing the charge.

Discussing the results by General Abbot's method as described in Professional Papers, No. 23, Corps of Engineers, the following equations result:

$$K = 46.4 \pm .67 \quad \ldots \quad (1)$$

$$E = 131 \quad \ldots \quad (2)$$

$$P = \sqrt[3]{\left[\frac{6636\,(S + 131)\,C}{(D + 0.01)^{21}}\right]^3} \quad \ldots \quad (3)$$

Comparing equation (3) with that for dynamite No. 1, I find the new explosive to have a strength of 86 per cent. that of the latter.

In deducing the above equations I have arbitrarily thrown out as abnormally large the records of gauge No. 1, shot 1; gauge No. 2, shot 2; gauge No. 2, shot 3; gauge No. 2, shot 4; gauge No. 4, shot 9; gauge No. 4, shot 11. The leads in these cases were set up more or less obliquely, and the large compression recorded may be due to this fact.

Summary of experiments.

THIN CASES.

No. of shot.	Charge.		Ring.	Distance to gauge.	Pressure per square inch mean of gauges.		
	Weight.	Condition.			Observed.	Computed.	Difference.
			Feet.	*Feet.*			
1	2	Dry, uncompressed	4	1.62	10,718	10,339	+379
2	2	do	4	1.62	10,649		+310
3	2	do	4	1.62	10,382		+ 43
4	2	do	4	1.62	10,847		+508
5	2	do	4	1.62	9,862		—477
6	1	do	4	1.62	6,489	6,513	— 24
9	1	do	4	1.62	6,045		—468
10	1	do	4	1.62	6,632		+119
11	1	do	4	1.62	5,827		—686
12	1	do	4	1.62	6,535		+ 22
13	1	do	4	1.62	5,968		—545
14	1	do	4	1.62	7,068		+555
15	1	do	4	1.62	7,009		+496

The density of the explosive is very great. A small charge in the form of a powder placed in a bottle and settled by gentle tapping gave a weight of 1.99 times that of an equal quantity of water.

The sample under test proved to be less sensitive to explosion by percussion under the hammer than dynamite No. 1 or rackarock.

Very respectfully, your obedient servant,

S. W. ROESSLER,
Captain of Engineers.

The POST ADJUTANT.

3.

TORPEDO DEPARTMENT,
Willets Point, New York Harbor, April 29, 1889.

SIR: I have the honor to submit herewith a record of some ring firing experiments made April 28, 1890, to determine the condition as to strength of our present supply of dynamite No. 1, purchased in 1877:

Number of shots fired, 10. Charge, 1 pound. Case containing charge, fuze can. Ignition, one service low-tension fuze. Ring, 3 feet diameter. Gauge, No. 1. Number of gauges, 6. Leads, 0.4 inch diameter. Distance from center of charge to piston head, 1.12 feet. Submergence, 35 feet. Depth of water, 75 feet.

The explosive was dry and uncompressed, being placed loosely in the fuze can without pressure or tamping.

Discussing the data by General Abbot's method, the following equations result:

$$K=61.7 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$E=204 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

and for the pressure in the vertical plane through the center of the charge,

$$P=\sqrt[3]{\left[\frac{6636\,(D+204)\,C}{[D+0.01]^{2.1}}\right]^3} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

This last equation represents an intensity of 4 per cent. greater than that given by the general equation for dynamite No. 1, as given on page 81, Professional Papers, No 23.

The details of the experiments are given on pages 1, 2, 3, and 4 of inclosure, the deduction of constant "K" on page 5, and a summary of the experiments on page 6.

Very respectfully, your obedient servant,

S. W. ROESSLER,
Captain of Engineers.

The POST ADJUTANT.

APPENDIX E.—REPORT OF LIEUTENANT HENRY JERVEY, CORPS OF ENGINEERS, ON RESULTS OF TESTS OF POWER OF VARIOUS EXPLOSIVES.

WILLETS POINT, NEW YORK HARBOR, *July* 18, 1890.

SIR: I have the honor to submit herewith the results of tests of the power of various explosives made during the months of May, June, and July, 1890, the first group by Lieutenant Harding, Corps of Engineers, the second by myself:

GROUP I.

[Weight of projectile: 17¼ pounds. Friction (assumed): 4¼ pounds.]

Explosive.	Weight.	Fuze.	Number of shots.	Mean rise of projectile.
	Grains.			*Feet.*
Mercury fulminate (a service fuze)	24	.....	8	0.70
Rac-a-rock	30	S. F.	8	3.27
Dynamite No. 1	15	C. F.	3	1.20
Do	30	S. F.	4	5.46
Do	40	S. F.	2	6.32
Do	50	S. F.	1	7.91
Colonel Alexander's powder, glazed	30	S. F.	3	2.82
Do	60	S. F.	1	5.31
Do	90	S. F.	1	11.38
Mr. Device's explosive	45	S. F.	1	3.80
Do	90	S. F.	2	6.25
Emmen's smokeless gelbite	35	S. F.	2	5.44
Colonel Alexander's powder, unglazed	90	S. F.	3	10.17
Emmensite No. 2 (S-F)	90	S. F.	4	5.61
Do	110	S. F.	1	7.84
Do	120	S. F.	2	11.04
Emmensite No. 1 (S-G)	90	S. F.	1	7.15
Do	110	S. F.	5	10.58

GROUP II.

[Weight of projectile: 35¼ pounds. Friction: 4¼ pounds.]

Gun-cotton, wet uncompressed	120	S. F.	8	9.89
Do	90	S. F.	2	7.25
Gun-cotton, compressed	120	S. F.	4	8.57
Do	135	S. F.	2	10.35
Do	140	S. F.	3	10.28
Dynamite, No. 1	90	S. F.	5	4.96
Do	120	S. F.	6	10.43
Dynamite, No. 2	120	S. F.	3	4.28
Do	140	S. F.	4	5.00
Do	160	S. F.	4	7.81
Do	180	S. F.	2	8.65
Tonite, compressed	30	S. F.	8	0.85
Do	70	S. F.	10	2.34
Do	110	S. F.	18	4.83
Do	150	S. F.	20	8.36
Tonite, uncompressed	40	S. F.	10	1.37
Do	80	S. F.	10	3.48
Do	120	S. F.	16	6.37
Do	150	S. F.	4	9.51
Do	160	S. F.	8	9.55
Orange lightning powder, No. 2	240	S. F.	5	7.00
Orange lightning powder, No. 3	100	S. F.	7	1.73
Do	160	S. F.	8	3.06
Do	220	S. F.	8	5.08
Do	240	S. F.	5	7.05
Oliver patent rifle, No. 1	240	S. F.	4	3.80
Oliver patent rifle, No. 2	240	S. F.	5	4.95
Do	120	S. F.	9	1.01
Do	180	S. F.	10	2.05
Oliver rifle powder, No. 1	120	C. F.	3	0.39
Do	240	C. F.	3	2.46
Do	240	S. F.	9	3.60

Several shots were made with the different grades of emmensite, but the results showed such irregularity that they have not been recorded in the above. The papers containing small charges of emmensite would, after a few days (in a closed dry box) appear to be soaked in a greasy liquid, and when burned, gave a slight crackling

sound. The emmensite itself seemed slightly moist, darker in color, and diminished in weight.

The value (4¼ pounds) for the friction of the projectile on the guides was obtained by moving the projectile steadily up and down the guides by means of a differential pulley, a spring balance being placed between the projectile and the pulley, and read every foot.

Diagrams corresponding to Groups I and II, respectively, accompany this report.

Very respectfully, your obedient servant,

HENRY JERVEY,
Second Lieut. of Engineers.

The POST ADJUTANT.

APPENDIX F.—REPORT OF LIEUTENANT CHESTER HARDING, CORPS OF ENGINEERS, OF RESULTS OF EXPERIMENTS ON THE SENSITIVENESS OF EXPLOSIVES.

WILLETS POINT, NEW YORK HARBOR, *February* 14, 1890.

SIR: I have the honor to submit a report of the results of the experiments on the sensitiveness of explosives.

The dimensions of the apparatus used are given on plate C.

The weight of the hammer, including that of the two iron bars connecting it with the center of rotation, is 23.72 pounds. The dimensions of the hammer are, roughly, 6 by 3 by 1.5 inches, and of each of the two bars, 24 by 2 by one-half inches.

If we assume that for a given position of the axis the sensitiveness of the explosive is proportional to the energy required to detonate it, we may compare sensitiveness by reference to the heights necessary to produce detonation for the given position of the axis, since the energies involved vary directly as the first powers of these heights.

Frequently, during the experiments, an explosive would detonate after repeated drops of the hammer from a height which failed to cause an explosion at the first blow.

The temperature of the room varied only 3° C—from 9° to 12° C—during the course of the experiments; no information was gained, therefore, as to the variation of sensitiveness with temperature.

I inclose a tabulated record of the results of the experiments, the explosives being arranged in the order of sensitiveness. The list comprises all the explosives Sergeant Brown could find on hand at this post.

Very respectfully, your obedient servant,

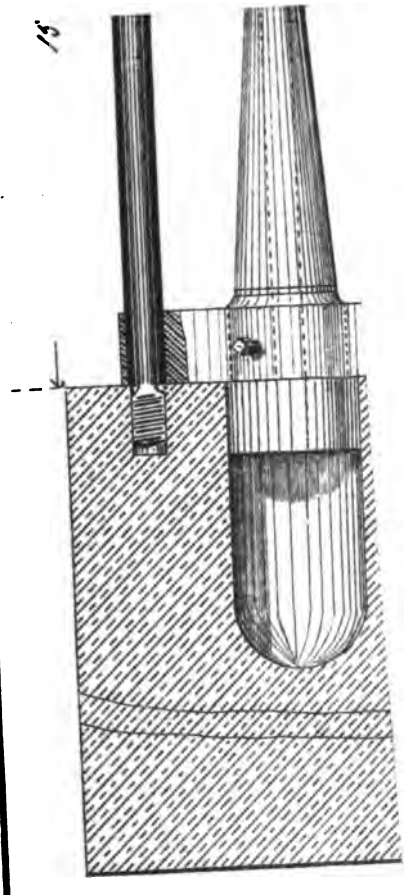
CHESTER HARDING,
Additional Second Lieut. of Engineers.

The POST ADJUTANT.

Table showing relative sensitiveness of explosives, as determined by experiments conducted during the month of January, 1890.

Name of explosive.	Weight of explosive.	Hole in arc occupied by axis.	Height above anvil necessary to produce explosion.	Name of explosive.	Weight of explosive.	Hole in arc occupied by axis.	Height above anvil necessary to produce explosion.
	Grains.		*Inch.*		*Grains.*		*Inch.*
Mercuric fulminate	2	9	½	Gunpowder, in brass	1	9	2
Forcite (95 per cent.)	1.25	9	½	Gelbite, smokeless	1.5	9	2½
Explosive gelatine	1.25	9	½	White gunpowder	5	9	2½
Explosive gelatine from Captain Maguire	1	9	¾	Tonite:			
Forcite (75 per cent.)	2.5	9	¾	Uncompressed	2.5	9	3
Gunnery powder	2	9	1	Compressed	2.5	9	3
Do	½	1	3½	Vulcan powder	2.5	9	3
Rac-a-rock *	2.5	9	1½	Atlas powder, A	2.5	9	3
Micar powder	5	9	1½	Russian powder, hot pressed	5	9	3
Dynamite No. 1:				Hercules powder No. 1	2	9	3
Thawed	2.5	9	2	Forcite (40 per cent.)	2.5	9	3
Frozen	2.5	5	3	Do	2.5	1	7
Do	2.5	1	4	Dualin	2.5	9	3

* The solid and liquid constituents of rack-a-rock were tested separately and found to be non-explosive under the hammer.



SCALE

Table showing relative sensitiveness of explosives, etc.—Continued.

Name of explosive.	Weight of explosive.	Hole in arc occupied by axis.	Height above anvil necessary to produce explosion.	Name of explosive.	Weight of explosive.	Hole in arc occupied by axis.	Height above anvil necessary to produce explosion.
	Grains.		*Inch.*		*Grains.*		*Inch.*
Atlas powder, B	2.5	9	3½	Picrate:			
Granulated gun-cotton	2.5	9	4	No. 2, 1877	1	9	6
Gun-cotton:				No. 0, 1877	1	9	7
Wet, uncompressed	2.5	9	4	Mammoth powder	10	9	8
Dry, compressed	2.5	9	4	Electric powder No. 1	5	9	10
Rendrock	5	9	4	Mortar powder	10	9	10
Collodion cotton	1.5	9	4	Bruyere (Picric)	1	9	10
Forcite (20 per cent.)	2.5	9	4	Emmensite (G-G)	10	9	11½
Gunpowder, in copper	5	9	5	Emmensite (G-F)	2	9	11½
Rifle powder, service	10	9	5	Emmensite (S-F)	10	9	11½
Orange lightning powder	5	9	5½	Emmensite (S-G)	10	9	11½
Oliver powder No. 1	5	9	6	Cannon powder	10	9	12
Hercules powder No. 2	2	9	6	Cocoa powder, Dupont	10	9	12
Judson powder (30 per cent.)	5	9	6	Picrate No. 1, 1877	1	9	14
				Designolle	5	9	14

APPENDIX H.—REPORTS OF CAPTAIN SOLOMON W. ROESSLER, CORPS OF ENGINEERS ON TESTS OF INSULATED CABLE.

1.

WILLETS POINT, NEW YORK HARBOR, *January 28*, 1890.

I again tested this morning the two samples of insulated cable (seamless) furnished by the "Safety Insulated Wire and Cable Company."

Sample No. 1—Plain insulation, 500 feet length. Insulation resistance reduced to 75° Fahr.: 1,779 megohms per mile after two hours' submersion, and 1,064 megohms after twenty hours' submersion.

Sample No. 2.—Braided insulation, 250 feet long. Insulation resistance reduced to 75° Fahr.: 763 megohms after two hours' submersion, and 814 megohms after twenty hours' submersion. Strength of battery, 234 volts.

The resistances correspond to the galvanic deflections after one minute's electrification.

The galvanic deflections were very small on account of the small lengths of cable under test, an error of .1 in estimating the fraction of a division of the scale corresponding to an error of many megohms in the result.

Very respectfully,

S. W. ROESSLER,
Captain of Engineers.

Colonel KING.

2.

TORPEDO DEPARTMENT,
Willets Point, New York Harbor, February 4, 1890.

SIR: I have the honor to submit the following report of the tests which have been made up to date to determine the insulation resistances of the cables stored in the laboratory tank.

SILVERTOWN SINGLE CONDUCTOR NO. 37.

Manufactured in 1873, and received at Willets Point, January 1, 1874. Stored in cable casemate No. 7 until transferred September 6, 1886, to the laboratory tank. Length of cable, 2 miles.

The insulation resistance immediately after being placed in the tank, as determined by a hasty measurement, *was 180 megohms* per mile at 75° Fahr.; the follow-

ing day 146.9 megohms; September 8, 39 megohms; September 14, 2.15 megohms. On September 14, the cable was raised from the tank to make room for a fish cable, and returned to the tank September 21, the inner end having been re-wrapped and paraffined. On September 22, the insulation was .75 megohms per mile; September 24, .95; September 27, 1. Cable raised September 27, and inner end reparaffined. Insulation resistance on September 28, 1.07 megohms. Cable raised and re-reeled on September 28. Insulation on September 29, .24 megohms; October 1, .67 megohms; October 4, 1.15 megohms; October 5, .77 megohms; October 6, .82 megohms; November 19, .39 megohms. Cable raised November 22, to make room for a Hooper cable and put back into the tank November 30. On December 3, 1886, the insulation was .36 megohms and from this date became practically uniform, gradually falling to .22 megohms on April 16, 1888. On January 8, 1890, Lieutenant Judson determined the insulation to be 1.82 megohms. The cable was then raised and about 25 feet cut off from the wetted end. The cable was put back the same day and the tank, which had been partially pumped out, was refilled with fresh water. The insulation was determined by myself January 31, 1890, to be 5.1 megohms per mile at 75° Fahr.; and on February 1, 2.3 megohms.

Lowest E. M. F. used during the tests, 230 volts.

SILVERTOWN SINGLE CONDUCTOR SAMPLE DRUM NO. 222.

The cable was received January 1, 1874, and cut into two lengths, August 20, 1874. There is only one recorded test of the first half of the drum, giving 257.7 megohms per mile at 75° Fahr. The following are the tests made with the second half of the drum:

April 10, 1875, three observations, giving 1,805, 1,220, 2,306 megohms per mile at 75° Fahr.

	Megohms.		Megohms.
June 29, 1875	1,821	Nov. 19, 1886	.260
June 30, 1875 (static charge method)	5,700	Nov. 24, 1886	.270
Nov. 29, 1875	354	Nov. 26, 1886	.280
Apr. 11, 1876	298	Nov. 29, 1886	.270
May 22, 1879	.161	Dec. 3, 1886	.310
May 22, 1879	1.310	Jan. 4, 1887	.300
Jan. 12, 1882	.127	Jan. 4, 1887	.300
May 16, 1882	3.890	Jan. 4, 1887	.210
May 30, 1882	3.680	Jan. 4, 1887	.310
Aug. 19, 1886	.190	Jan. 4, 1867	.140
Aug. 21, 1886	.080	Feb. 9, 1888 (fault near one end)	*5,661
Aug. 25, 1886	.150		

There are no further recorded tests until that made by Lieutenant Judson, January 8, 1890, giving an insulation of 10.8 megohms per mile. The cable was then raised and about 25 feet cut off from one end.

January 31, I determined the insulation to be 4.1 megohms, and February 1, 6.5 megohms per mile at 75° Fahr. Lowest voltage used in any of the tests, 230.

HENLEY SINGLE CONDUCTOR CABLE—SAMPLE MILE.

Received 1874, Insulation, India rubber; manufacturer's test, 5,264 megohms per mile at 75° Fahr.

	Megohms.		Megohms.
June 29, 1875	2,320	Aug. 19, 1886	1,173
June 30, 1875 (static charge method)	25,340	Aug. 19, 1886	1,135
Oct. 11, 1876	724	Aug. 19, 1886	1,135
May 22, 1879	133	Aug. 21, 1886	1,059.8
May 22, 1879	.47	Aug. 25, 1886	917
May 22, 1879	.18	Nov. 19, 1886	642.2
Dec. 31, 1881	1,912	Nov. 24, 1886	544.5
Dec. 31, 1881 (static charge method)	1,779	Nov. 26, 1886	803.7
Jan. 11, 1882	122	Nov. 29, 1886	408.7
May 16, 1882 (over)	10	Dec. 3, 1886	838.2
May 27, 1882	20	Feb. 9, 1888	16.2
May 30, 1882	29.1	Feb. 23, 1888	16
		Apr. 16, 1888	15.9
		Jan. 8, 1890	100.8

The tank was partially emptied to raise a Silvertown cable and then refilled with fresh water.

*Ohms.

	Megohms.		Megohms
Jan. 31, 1890	68	Feb. 1, 1890	85.6

Lowest voltage used during any of the tests, 230.

HENLEY SINGLE CONDUCTOR CABLE—SAMPLE MILE.

Insulation, ozokerite; manufacturer's test, 7,328 megohms per mile at 75° Fahr.

	Megohms.		Megohms.
Oct. 27, 1881 (static charge)	3,309	Nov. 29, 1886	6,130
Jan. 12, 1882 (static charge and deflection)	8,125	Dec. 3, 1886	6,035
May 23, 1882 (static charge and deflection)	12,290	Jan. 7, 1887	7,537
May 30, 1882 (static charge and deflection)	12,530	Jan. 7, 1887	7,573
Aug. 19, 1886	4,264	Jan. 7, 1887	3,750
Aug. 21, 1886	4,088	Jan. 7, 1887	5,083
Aug. 25, 1886	3,282	Jan. 7, 1887	3,749
Nov. 19, 1886	4,014	Feb. 9, 1888	4,279
Nov. 24, 1886	4,562	Feb. 23, 1888	5,644
Nov. 26, 1886	6,751	Apr. 16, 1888	6,987
		Sept. 28, 1888	6,147
		Jan. 8, 1890	(?) 420

Tank partially emptied to permit removal of a Silvertown cable and refilled with fresh water.

	Megohms.		Megohms.
January 31, 1890	4,439	February 1, 1890	6,476

Lowest voltage used in any test, 213.

When not otherwise stated the method used was that by deflections. The resistances given are those taken at the end of the first minute.

Very respectfully, your obedient servant,

S. W. ROESSLER,
Captain of Engineers.

The POST ADJUTANT.

APPENDIX I.—REPORTS OF LIEUTENANT ALBERT M. D'ARMIT, CORPS OF ENGINEERS, ON TESTS OF BUILDING MATERIALS.

1.

WILLETS POINT, NEW YORK HARBOR, *February* 12, 1890.

COLONEL: I have the honor to submit below the results of the tests directed by you to be made on certain specimens of sandstones from the Great Kanawha quarries. The tests were conducted in the same manner as were General Gilmore's and those previously made at this post by Lieutenant Rees. In the columns headed "Ratio of absorption" some additional results are recorded. Specimens were saturated under atmospheric pressure, and column 2 gives the percentage of absorption. The specimens were also saturated under a pressure of 50 pounds per square inch and the results are contained in column 3. In column 4 are given the final results of immersing the specimens under a varying series of pressures culminating in 300 pounds per square inch. The total time in water was about one and one-half hours, and the rate of increase of absorption was very slow after the first ten minutes—due far more, apparently, to the length of time than to any increase of pressure—indicating that very high pressure produces little effect, although the absorption under pressure for the same length of time is materially increased over the atmospheric percentage, as shown by a comparison of columns 3 and 2. In column 1 the result of drying the specimens and then testing for absorption is given. The abnormal percentages seem to indicate that under the high pressure to which they had been subjected the constitution of the specimens had been affected, rendering them more permeable by the water.

The column headed "Durability" was obtained by taking the percentage of loss of the specimens, after several hours' handling in a saturated condition and affords some idea of the relative value of the stones where exposed to driving rains.

Very respectfully, your obedient servant,

A. M. D'ARMIT,
Second Lieutenant of Engineers.

Lieut. Col. W. R. KING,
Corps of Engineers.

Results of tests of sandstones from the Great Kanawha quarries.

No.	Quarry.	Description.	Position.	Strength of specimen.	Strength per square inch.	Specific gravity.	Weight per cubic foot.
1	Sattis Ravine, top ledge.	Gray, purplish streaks	On bed....	29750	7438	2.37	148.1
2	Sattis Ravine, middle ledge.	....do	.....	30800	7700	2.37	148.1
3	....do.....	Gray	On bed....	33800	8450	2.24	140.0
4	Sattis Ravine, bottom ledge.	Greenish gray, fine grained, compact.	....do	45000	11250	2.36	147.5
5	....do.....	Not so fine as No. 4, poorer specimen generally.	....do	42750	10687	2.4	150.0
6	Gabbart's Bowlder.	Coarse, friable, contains quartz grains.	.....	44250	11062	2.26	141.2
7	....do.....	....do	On bed....	36800	9200	2.35	146.8
8	Gabbart's main ledge.	Clearly stratified, layers homogeneous but dissimilar.	....do	33200	8300	2.21	138.1

Quarry.	Ratio of absorption.				Durability.	Temperature.	Remarks.
	1.	2.	3.	4.			
	Atmosphere, 10 minutes.	Atmosphere, 2½ hours.	50 pounds square inches, 2½ hours.	300 pounds square inch, 1½ hours.			
Sattis Ravine, top ledge.	.0401	.0437	.0446	.0473	.9949	72°	Cracked violently.
Sattis Ravine, middle ledge	.0395	.0288	.0467	.043	.9964	72°	Evidently on bed from nature of fracture.
Do.....	.0555	.045	.059	.051	.9858	72°	Sudden crack, followed by complete crushing.
Sattis Ravine, bottom ledge	.0309	.0302	.0371	.0346	1.000	72°	Crumbled to dust; pieces small; a very homogeneous specimen and typical fracture.
Do.....	.0482	.0377	.0504	.0522	.9934	72°	A much coarser stone; not so much stone dust; cones of fracture slipped, reducing strength of specimen.
Gabbart's Bowlder	.0493	.0478	.0515	.0488	.999	72°	Split from all four sides, leaving a very perfect pyramid.
Do.....	.0472	.0511	.0515	.05	.998	72°	Very characteristic fracture.
Gabbart's main ledge...	.0421	.025	.051	.044	.991	72°	Shows typical fracture, notwithstanding lack of similarity in layers; crushed on edge, its strength would probably be materially diminished.

WILLETS POINT, NEW YORK HARBOR, *June* 5, 1890.

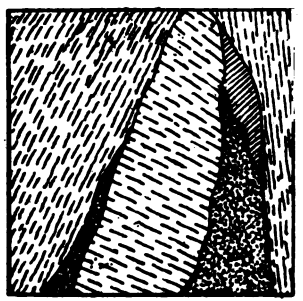
COLONEL: I have the honor to submit herewith my report of the results of tests directed by you to be made on the *cement* being used in the construction of the mining casement at this point.

The cement is known as "*Rosendale*," and was purchased in open market, with no knowledge that tests were to be made. Samples were taken from different barrels at random and mixed. In the construction of the work the cement is mixed with sand in the ratio of, cement one part, sand two parts. Samples of this mixture were taken from the box just as it was being used in actual work.

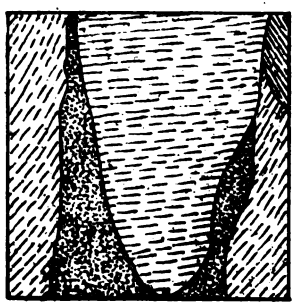
The machine used for testing was the wooden frame formerly used for testing wire. This was placed in a vertical position, a hook bolted to the lower end, with a second hook fastened to the upper cross-bar by a long rod having a thread about 15 inches long. Between these hooks were fastened a scale beam and the clutches containing the specimen. While one man turned the nut of the threaded rod, thus gradually increasing the stress, another man kept the scale beam balanced. The reading of the

Sketches of Fractures. (Front view)

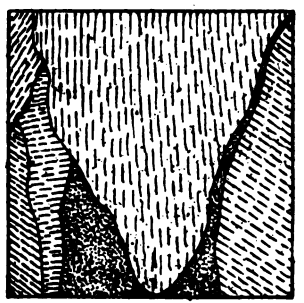
No. 1.



No. 2.

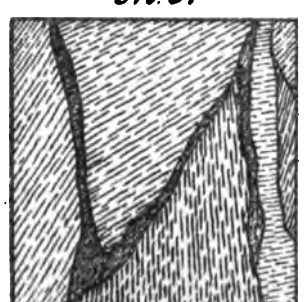


No. 3.

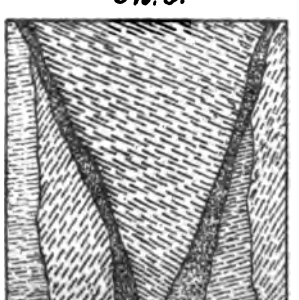


No. 4

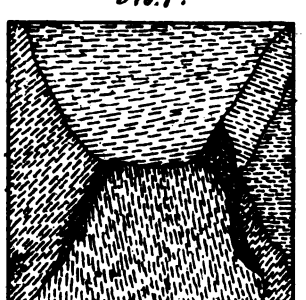
No. 5.



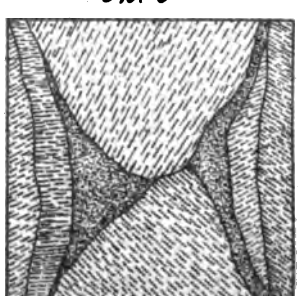
No. 6.



No. 7.



No. 8



Eng 90

scale at rupture, minus the constant weight of the upper clutch and hook, gave the breaking stress in pounds. This device has now been changed so that a carefully graduated spring balance replaces the scale beam, rendering the manipulation much easier and equally accurate. This will be used in future experiments. The clutches used consist of one of the molds in which the specimens were made cut across its middle section, thus enabling the specimen to be grasped by the clutches uniformly over its bearing surface. Some slight defects showed themselves in the working of this clutch which, however, will be easily remedied so as to render it perfectly satisfactory.

The specimens were briquettes made in the molds accompanying the hydraulic press used by General Gillmore and present a minimum cross-section of 2¼ square inches. The cement was carefully mixed with as little water as possible and very carefully rammed into the molds. After settling for twenty-four hours in air the specimens were placed in water for seven days and then broken. One specimen of pure cement and one of the mixture were left in air for eight days. The table below gives the results of the tests of the pure cement briquettes. The sand specimens were easily ruptured by a slight pull with the hands, in no case exceeding 20 pounds. This being deemed unsatisfactory some rough tests were made as to their compression strength, with results showing that a pressure of about 9 pounds per square inch would completely crush the best made specimens; some poorly made ones crumbled in the hands after three days' setting in air; all of which seems to indicate that the cement as being used with two parts of sand can possess little useful strength.

In about two hours the pure cement was set, while at the end of twenty-four hours the mixed cement could still be indented by the finger. Some specimens are still in the water, with a view to testing after thirty days, the results of which will be duly reported.

Number.	Strength of specimen.	Strength per square inch.	Remarks.
1	300	133⅓	8 days in air.
2	225	100	1 day in air and 7 days in water.
3	260	116	Do.
4	240	107	Do.
5	220	98	Do.
6	225	100	Do.
7	200	89	Do.

Mean of 2 to 7, inclusive, 228 per specimen; 102 per square inch.

Further tests of compressive strength as well as transverse will be made as soon as the necessary molds are secured.

Very respectfully, your obedient servant,

A. M. D'ARMIT,
Second Lieutenant of Engineers.

Lieut. Col. W. R. KING,
Corps of Engineers.

3.

WILLETS POINT, NEW YORK HARBOR, *March* 22, 1890.

COLONEL: I have the honor to submit herewith my report on the concluding tests of the series made to determine the value of the Rosendale cement being used in the construction of the mining casemate at this post.

The improvements mentioned in my previous report have been made, and the apparatus now works very satisfactorily. The spring balance records the pressure exactly, and the differential pulley allows a gradually increasing pressure to be applied, which may be continued at any desired amount for an indefinite time.

The briquettes tested were parts of the same two lots mentioned in my previous report. They were thirty days old, having been twenty-nine days in water.

The ones made of sand and cement showed but little tensile strength. There undoubtedly was an increase over the strength shown at the end of seven days, about twice the force being necessary for rupture; still a pull with the hands was sufficient to break even the strongest. In no case did they show a strength of more than 10 pounds per square inch. All of these sand briquettes were of the first lot and had been very carefully made by an expert workman. The second lot of pure cement briquettes had been made by a less skilled workman, and at the end of thirty days showed less strength than had the better-made ones at the end of seven days. The latter specimens at the end of *thirty days* showed no appreciable gain in strength, the

maximum stress sustained being 118 pounds per square inch, while the average was practically the same as before.

The result of the experiments would seem to be that, with this cement when pure, little increased strength is gained after seven days; when used with sand there is undoubtedly a gain, but the maximum strength developed is very low.

Very respectfully, your obedient servant,

A. M. D'ARMIT,
Second Lieutenant of Engineers.

Lieut. Col. W. R. KING,
Corps of Engineers.

4.

WILLETS POINT, NEW YORK HARBOR, *May* 16, 1890.

COLONEL: I have the honor to submit herewith the results of the tests directed by you to be made on certain specimens of sandstone. The experiments were conducted as previous ones have been, except that as there were eight specimens of but three quarries I tried but one with pine, using pasteboard for the others, and I desire to call attention to the much higher strength thus developed and the much more nearly typical fracture produced. The pine strips invariably tend to break the stone by lateral spread. I also call attention to the exceptional quality of these sandstones, their high specific gravity, low ratio of absorption, and remarkable uniform structure. All of the specimens were crushed "on bed."

Very respectfully, your obedient servant,

A. M. D'ARMIT,
Second Lieutenant of Engineers.

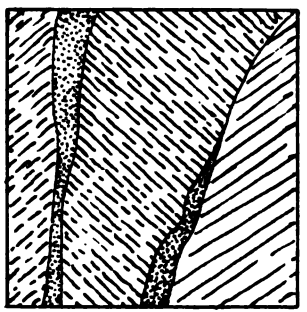
Lieut. Col. W. R. KING,
Corps of Engineers.

Result of test of sandstones from Great Kanawha quarries.

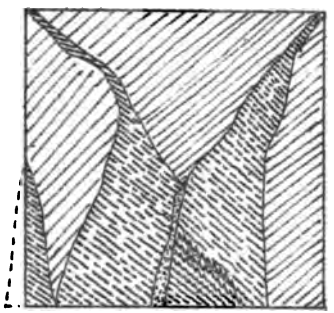
No.	Quarry.	Description.	Strength of specimen.	Strength per square inch.	Specific gravity.		Weight per cubic foot.	Ratio of absorption.	Temperature (Fahr.).	Remarks.
								P. ct.	°	
1	Elk-Burton	Light gray, fine, granular.	22,000	5,500	2.49	2.44	155.6	2.5	73	Split from the side. A very even structure, but not a characteristic break (pine).
2	....do	....do	44,000	11,000	2.46		153.7	2.9	73	A very fine stone. Broke purely by crushing. No lateral giving. Two perfect cones. (Pasteboard.)
3	....do	....do	50,000	12,500	2.38		148.7	3.2	73	Completely crushed. But one cone. (Pasteboard.)
4	Elk quarries	Coarser, not so homogeneous bands of finer purple material.	40,000	10,000		2.45	153.1	3.3	73	Split evenly from all sides giving typical cones. (Pine.)
5	Dunn	Very light gray, very even, compact structure.	33,000	8,250	2.44	2.445	152.5	3.1	73	Cracked at 24,000 pounds. Broke by splitting. (Pine.)
6	....do	...do	47,000	11,750	2.45		153.1	2.5	73	(Pasteboard.)
7	Carmelton [Davis.]	Greenish tinge, very fine, even and compact structure.	40,500	10,125	2.58	2.57	161.2	2.2	73	Completely split up in all directions. (Pine.)
8	....do	....do	61,800	15,450	2.56		160.0	2.5	73	Complete crushing. Good cones. (Pasteboard.)

Sketches of Fractures (: Front view :)

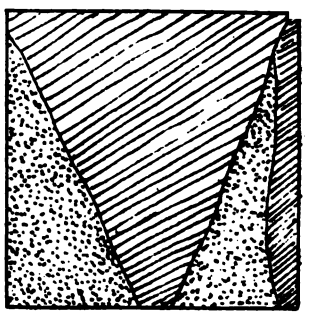
No 1.



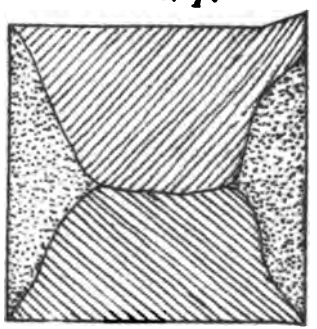
No. 2



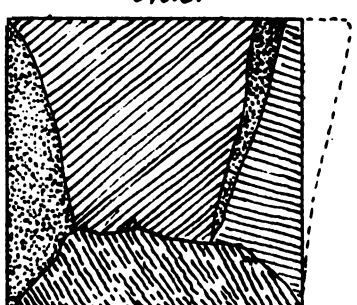
No. 3.



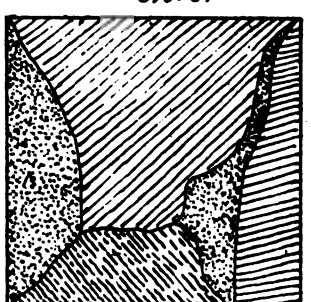
No. 4.



No. 5.



No. 6.



No. 7.

No. 8.

Eng 90

5.

WILLETS POINT, NEW YORK HARBOR, *June* 5, 1890.

COLONEL: I have the honor to submit below my report of the tests made of the strength of a specimen brick, sent from Tennessee to be tested, and claimed by the makers to be as strong as granite.

The brick was reduced to the form of small cubes, approximately 2 inches on the edge. Owing to its great hardness extreme difficulty attended this operation, and but three cubes were obtained. These were tested with the hydraulic press, pasteboard being used as the bearing surface. In order to compare with ordinary brick ten bricks were selected from those now being used in the construction of the museum. These were selected, not at random, but with great care, so as to obtain the *best* specimens. Upon being crushed the common brick displayed the fracture shown by sandstone when crushed *on edge*. The characteristic cones seen in crushing stones "on bed" were totally absent. The Tennesee brick, when near its rupturing pressure, gave a low rustling sound similar to the tearing of paper, then, as the pressure was increased a few thousand pounds, the noise increased until suddenly the whole specimen gave way completely, no fragments as large as a small marble remaining. Altogether the brick displayed very satisfactory qualities, and as compared to ordinary brick is far superior, while it is, as claimed, but little inferior to granite itself in strength.

Number.	Strength (crushing) per square inch.	Number	Strength (crushing) per square inch.
	Pounds.		*Pounds.*
1	3,550	8	5,220
2	5,000	9	3,000
3	3,550	10	2,660
4	6,550	1[a]	17,000
5	5,440	2[a]	16,100
6	4,330	3[a]	13,700
7	4,220		

Mean of Nos. 2, 3, 4, 5, 6, 7, and 8, 5,126 pounds per square inch.

Mean of 1[a], 2[a], and 3[a], 15,600 pounds per square inch. Ratio of Tennessee to common brick 3:1. Specimens 1, 9, and 10 are omitted from the average as by inspection they could be seen to be soft, light brick of a light-red color. The effect of thorough burning is apparent in No. 4, which was an arch brick and burned to a blue color.

Mean specific gravity of three specimens of common brick 1.919
Mean specific gravity of two specimens of Tennessee brick 2.052
Mean absorptive ratio of nine specimens of common brick ..... .09977
Mean absorptive ratio of six specimens of Tennessee brick ..... .03123
Ratio of absorptive powers, 1:3.2.

The specimens were thoroughly saturated, being immersed four days. The low absorptive power of the Tennessee brick is especially noteworthy, being considerably less than that of the best specimens of sandstone.

Very respectfully, your obedient servant,

A. M. D'ARMIT,
Second Lieutenant of Engineers.

Lieut. Col. W. R. KING,
Corps of Engineers.

RIVERS AND HARBORS, ETC.

APPENDIX A.

IMPROVEMENT OF RIVERS AND HARBORS IN THE STATES OF MAINE AND NEW HAMPSHIRE.

REPORT OF LIEUTENANT-COLONEL JARED A. SMITH, CORPS OF ENGINEERS, OFFICER IN CHARGE FOR THE FISCAL YEAR ENDING JUNE 30, 1890, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Lubec Channel, Maine.
2. Moose-a-bec Bar, Maine.
3. Narraguagus River, Maine.
4. Breakwater from Mount Desert to Porcupine Island, Maine.
5. Bagaduce River, Maine.
6. Penobscot River, Maine.
7. Belfast Harbor, Maine.
8. Camden Harbor, Maine.
9. Rockport Harbor, Maine.
10. Rockland Harbor, Maine.
11. Kennebec River, Maine.
12. Portland Harbor, Maine.
13. Channel in Back Cove, Portland, Maine.
14. Breakwater at mouth of Saco River, Maine.
15. Saco River, Maine.
16. Kennebunk River, Maine.
17. York Harbor, Maine.
18. Portsmouth Harbor, New Hampshire.
19. Bellamy River, New Hampshire.
20. Cocheco River, New Hampshire.
21. Harbor of Refuge at Little Harbor, New Hampshire.

EXAMINATIONS AND SURVEYS.

22. Belfast Harbor, Maine.
23. Union River and Union River Bay, Maine.
24. St. Croix River, Maine.
25. Pleasant River, from Columbia Falls to its mouth, Maine.
26. Kennebunk River, Maine.
27. Cocheco River, from Dover to its mouth, New Hampshire.

UNITED STATES ENGINEER OFFICE,
Portland, Me., July 10, 1890.

GENERAL: I have the honor to transmit herewith annual reports for the fiscal year ending June 30, 1890, for river and harbor works in my charge.

* * * * * * *

Very respectfully, your obedient servant,

JARED A. SMITH,
Lieut. Col., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

A 1.

IMPROVEMENT OF LUBEC CHANNEL, MAINE.

This channel lies between the eastern extremity of Maine and Campo-Bello Island, belonging to the Dominion of Canada.

Originally the channel was but 5 feet in depth at mean low water, and but 2 feet at low water of spring tides.

The project is for a channel 275 feet wide in the direct parts and 300 feet wide in the bends. Depth, 12 feet below mean low water. Total of appropriations to June 30, 1890, $169,000.

Total of expenditures to June 30, 1890, $157,213.03.

Under the contract reported last year dredging was commenced June 3, 1890, and will be continued as far as funds permit. This will entirely complete the improvement. The amount dredged in June was 20,286 cubic yards. The work will probably be completed in August.

The channel is a thoroughfare to various points on our eastern coast, as well as a factor of safety for the anchorage in Quoddy Roads, when the wind changes to easterly points.

Local statistics are therefore very incomplete, and there is no means of ascertaining the exact number of passing vessels.

In 1882 a record was kept of about 10,000 vessels passing Quoddy Head light-house. No subsequent record has been kept. A record of vessels seen to pass the life-saving station at Lubec in 1887, in day-time and clear weather, shows the number to be 8,683.

Lubec is in the collection district of Passamaquoddy. The nearest port of entry is Eastport, Me. The nearest light-house in the United States is on West Quoddy Head, about 7 miles below.

There is a Canadian light-house on Mulholland's Point, at the narrows opposite Lubec.

Money statement.

July 1, 1889, amount available		$19,506.77
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$612.70	
July 1, 1890, outstanding liabilities	7,107.10	
July 1, 1890, amount covered by uncompleted contracts made during fiscal year ending June 30, 1890	10,899.90	
		18,619.70
July 1, 1890, balance available		887.07

A 2.

IMPROVEMENT OF MOOSE-A-BEC BAR, MAINE.

This bar, at the eastern terminus of Moose-a-bec Reach, is near the town of Jonesport, about 30 miles east of Mount Desert.

The "Reach" is a thoroughfare of about 12 miles in length, which is traversed by thousands of vessels annually; in addition to this it forms an admirable harbor of refuge, and is used as such by many vessels, especially in the winter months.

The project of improvement adopted in 1881 and modified in 1888 comprises the dredging of a channel 300 feet wide and 14 feet deep at mean low water over the bar, to remove ledges in and near the channel to a depth of 16 feet, and to construct a small jetty to check cross-currents in the cut.

The total of appropriations for the work previous to June 30, 1890, is $55,000.

Expenditures to June 30, 1890, $53,417.68.

As indicated in the last annual report, the contractor for removing Steam-boat Ledge has failed to complete the work. As work had been carried on two seasons at a great loss to the contractor, and as the later project somewhat modified the former one, so that no loss to the improvement would result from the failure of the contractor, the contract has been annulled.

Only one payment, amounting to $739, was made, and the contractor thus forfeits the retained percentage, amounting to $81, in addition to the work accomplished for which no payments have been made.

Under the contract for dredging reported last year, the cut through the bar has been completed to its full width of 300 feet and 14 feet deep at mean low water.

Dredging was commenced August 28 and completed November 27.

The amount of material removed was 63,150 cubic yards, measured in scows. This has greatly improved the thoroughfare, through which passes almost a constant procession of vessels where before the improvement none could pass save at high water.

Attention is asked to the remarks in previous reports on this and other distant works regarding the impracticability of carrying on the work with small appropriations.

It is proposed to expend the balance of funds, and the amount which may be appropriated, in constructing the small jetty and in removing ledges.

The improvement is in the collection district of Machias, Me. The nearest lighthouse is Moose Peak.

Nearest port of entry is Machias, Me.

NOTE.—It is not practicable to obtain tonnage statistics of this thoroughfare. The number of vessels passing annually has been estimated to be as great as 25,000. The average tonnage will hardly be less than 300, which would give the estimated tonnage 7,500,000.

Money statement.

July 1, 1889, amount available	$22,447.36
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	20,865.04
July 1, 1890, balance available	1,582.32
Amount appropriated by act of September 19, 1890	15,000.00
Amount available for fiscal year ending June 30, 1891	16,582.32
Amount (estimated) required for completion of existing project	80,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	50,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

A 3.

IMPROVEMENT OF NARRAGUAGUS RIVER, MAINE.

The Narraguagus River proper is a small stream flowing across the southwestern portion of Washington County, but the navigable part of the river comprised in the project for improvement is really a tidal arm of the sea or Narraguagus Bay, below the town of Millbridge, which is at the head of navigation.

The project for improvement, originally estimated to cost $50,000, consists in deepening the channel by dredging.

The channel is to be from 200 to 300 feet wide, 11 feet deep to the lower landing, and thence 9 feet deep to the anchorage near Fickett's Point. Originally the depth was but 5½ feet at mean low water, and not more than 4 feet at very low stages.

By acts of August 5, 1886, and August 11, 1888, Congress appropriated $10,000, a total of $20,000.

Previous to June 30, 1889, the expenditures had been $10,259.58.

At the commencement of the fiscal year a contract had been made for dredging as far as could be done with available funds.

The contractor began dredging on the 20th of July, and completed the work August 17, a total period of less than one month.

Under this contract 44,988 cubic yards of material, measured in scows, were removed and dumped in deep water about one-half mile distant.

The channel is now dredged to grade, a width of 55 feet for a distance of 2,800 feet, thence 100 feet wide a distance of 1,000 feet, and then the full width of 300 feet, an average distance of 600 feet.

The upper part of channel dredged under the previous contract was found to be partially filled with saw-dust, so that it becomes questionable whether an improvement by dredging only will be reasonably permanent.

Steamers can now proceed to the lower wharf, and can turn in the wide place mentioned above. During last season two regular lines of steamers touched at Millbridge.

The mouth of the river is somewhat used as a refuge for steamers and other vessels in storms.

The commercial necessities are not extensive, but a considerable area of country is dependent upon it for a port.

The improvement is in the collection district of Machias. The nearest port of entry is Machias. The nearest light-house is Narraguagus light-house on Pond Island.

No special statistics for the last year have been received.

About 600 steamers and other vessels arrive and depart annually.

The imports in 1877 were approximately 10,000 tons. Exports, 6,500 tons.

Money statement.

July 1, 1889, amount available	$9,740.42
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	9,740.42
Amount appropriated by act of September 19, 1890	7,500.00
Amount (estimated) required for completion of existing project	22,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	22,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

A 4.

CONSTRUCTION OF A BREAKWATER FROM MOUNT DESERT TO PORCUPINE ISLAND, MAINE.

The necessity for improving this harbor arises from the fact that it is exposed to all winds and seas from the south and southeasterly directions, making the anchorage at times so insecure that vessels are unable to hold their positions.

At such times the landing of passengers and freight at wharves is not only difficult but dangerous.

The project consists in constructing a breakwater from Porcupine

Island to Dry Ledge, and thence in a direct line to a point near the shore of Mount Desert Island, a total distance of 3,425 feet.

The estimated cost of the entire breakwater including a superstructure is $800,000.

The act of August 11, 1888, appropriated $50,000 for commencing the work.

The last annual report gave the details of preparatory operations, including a contract with Mr. Fred. L. Andrews, of Biddeford, Me.

The delivery of stone was commenced July 1 and continued in an irregular and unsatisfactory way until November 5, the total amount being 11,393 tons.

On the 7th of November it was ascertained that the contractor, who had visited the office and received his monthly payment for November, had surreptitiously left the work and the vicinity, leaving a large number of creditors, mostly poor men. The debts of the contractor amounted, as far as can be ascertained, to $3,639.04, mainly for labor, stone, and freight.

No payments were made on deliveries in November, amounting to 267 tons.

There was no good and sufficient reason for suspending work at that time, as the weather was especially favorable and the laborers and masters of vessels employed were anxious to continue.

The limit of time for completion of work under the contract was June 30, 1890. The contractor has failed, therefore, not only to perform the work as stipulated, but has failed to pay for labor and materials for which he has himself been paid, save a small reserve.

The amount thus far done is not sufficient to produce a perceptible change in the condition of the harbor.

It is understood in the office that some uneasiness has obtained among the cottagers adjacent to the proposed work, caused by apprehensions that it might so stop the tidal currents as to precipitate the sewerage along the shore, or that it might form part of an annoying thoroughfare, or in some other way injure the shore. It is therefore well to explain that the end nearest to Mount Desert Island will not reach the shore by some 500 feet. The ebb and flood currents will naturally be made more rapid along that part of the shore so as to reduce rather than to increase the tendency to deposits.

The same condition makes it quite impossible to create a thoroughfare, and it leaves a good channel for small vessels to pass back and forth without the necessity of going around the island.

It is proposed to expend the present balance, and any more which may be appropriated, in extending the breakwater from the end next to Porcupine Island.

The work is in the collection district of Frenchman's Bay.

Nearest port of entry Ellsworth; nearest light-house is on Egg Rock, 3½ miles distant.

NOTE.—The latest statistics received are to June 30, 1889. (See Report Chief of Engineers, 1889, page 511.)

Money statement.

July 1, 1889, amount available	$49,007.16
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	12,718.94
July 1, 1890, balance available	36,288.22
Amount appropriated by act of September 19, 1890	50,000.00
Amount available for fiscal year ending June 30, 1891	86,288.22

Amount (estimated) required for completion of existing project	$700,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	150,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

A 5.

IMPROVEMENT OF BAGADUCE RIVER, MAINE.

The river and harbor act of August 5, 1886, required an examination or survey of the Bagaduce River, Maine.

A report with estimate of cost of works considered necessary was submitted by the engineer officer in charge February 2, 1888. (See Report of Chief of Engineers for 1888, page 401.)

The project adopted for the improvement consists of deepening the channel to give a width of 100 feet and a low-water depth of 6 feet from South Penobscot to Bridges Point; this includes dredging and removing rocks. The project also includes removing a small amount of rock in Johnson's Narrows.

By act of August 11, 1888, Congress appropriated $3,000 for the improvement.

As this small sum could not be judiciously expended in a way to accomplish any beneficial result, work on the improvement has been suspended to await the further action of Congress.

Previous to June 30, 1889, an expenditure of $100 from the appropriation was incurred in the necessary office work, preparing plans, estimates, etc.

To effect any valuable improvement of the channel all the rock must be first removed; but little result can come from the removal of a portion only.

The estimate of $24,427.90 for removing all the rock will probably not cover the expense if it can not be done in one contract.

The improvment is in the collection district of Castine.
The nearest port of entry is Castine.
The nearest light-house is Dice's Head light-house.

No replies have been received to requests for recent commercial statistics.

Money statement.

July 1, 1889, amount available	$2,900.00
July 1, 1890, balance available	2,900.00
Amount appropriated by act of September 19, 1890	4,000.00
Amount available for fiscal year ending June 30, 1891	6,900.00
Amount (estimated) required for completion of existing project	39,875.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	25,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

A 6.

IMPROVEMENT OF PENOBSCOT RIVER, MAINE.

The channel at Bangor and near Crosby's Narrows was originally too narrow to accommodate the numerous vessels and rafts.

A project was adopted in 1884 to widen the channel to 300 feet, giv-

ing 11 feet depth at extreme low water at Bangor and 12 feet depth at Crosby's Narrows.

In 1888 an additional project was adopted to deepen the shoals between Bucksport and Winterport to 22 feet at low water.

The estimated cost of the part above Crosby's Narrows was	$75,000.00
Part below Winterport	365,000.00
Total	440,000.00
Appropriations and allotments for first part of improvement to June 30, 1890	55,000.00
Allotment for part below Winterport	30,000.00
Total	85,000.00
Total expenditures for first part to June 30, 1890	35,426.87
Below Winterport	27,177.27
Total	62,604.14

The work of widening the channel at Bangor has been completed. The removing of shoals and widening of channel above Crosby's Narrows was commenced June 28, 1890, and dredging will be continued until available funds are expended. The amount removed in June was but 138 cubic yards.

The limit of time in which work under this contract—reported last year—may be completed has been extended to September 30, 1890.

The shoal near Crosby's Narrows is entirely of slabs, edgings, bark, and other mill-waste which has in years past been thrown into the river and its tributaries, and has become a tangled and compact mass, very difficult and expensive to remove.

Such material is not now thrown away to any extent as it was formerly, so that it is hoped that the bar may not form again after being removed.

Advertisements inviting proposals for dredging in the channel below Winterport were issued June 4. Proposals were received and opened July 2, 1890. The lowest bidder was Joshua B. Johnson, of Wilmington, Del., and the contract was awarded to him at 17 cents per cubic yard for material measured in scows.

Dredging was commenced early in August and continued until November 20, when it became necessary to suspend for the winter. The late floods in the spring delayed the resumption of work, but it was recommenced May 29, 1890, and continued until the close of the year.

Amount of material dredged during the year is 137,343.6 cubic yards.

The resulting area of channel dredged has been wider than was anticipated, for the reason that part of the material present when the survey and estimate was made, had been removed by some temporary condition which caused scouring, so that the amount of cubic yards which could be dredged with available funds extended over a large area.

When the dredge was placed upon the work it was found that the depths differed greatly from the depths in the same places when surveyed about two years before. This difference was so great that in many places where the material to be dredged was previously from 1 to 4 or more feet deep, no material was found above grade, and in other places more or less of filling had obtained. In one instance the filling was nearly 9 feet. It became necessary therefore to make another survey of the channel in order to relocate the work to be done.

The material moved has in very large part been of clear sawdust, though some very *soft sandy mud* has been found in places more or less

mixed with sawdust, and hard sand and bowlders have been found at the lower end of the cut on the east side.

The material corresponds exactly with the indications ascertained by borings. (See map opposite page 516, Report Chief of Engineers, 1888.)

In dredging the different cuts the material on the west side of channel has in general filled in after dredging at so rapid a rate that while the dredge moved over its own length in making a cut the soundings showed a fill of 2 or more feet.

The condition of the channel can not, therefore, be described until another survey shall show whether the dredging has caused any permanent result.

Penobscot River has a very extensive commerce, in which lumber and ice are the largest items. It has been impracticable to obtain complete commercial statistics in time to accompany this report. The statistics of the ports of Bangor, Winterport, and Bucksport for one year were quite fully given in annual report for 1887. (Report of Chief of Engineers, 1887, pages 444 and 445.)

Bangor, at head of navigation, is a port of entry.
Fort Knox is at the narrows opposite Bucksport.

Money statement.

July 1, 1889, amount available		$49,238.44
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$21,994.57	
July 1, 1890, outstanding liabilities	4,848.01	
July 1, 1890, amount covered by uncompleted contracts made during fiscal year ending June 30, 1890	20,713.96	
		47,556.54
July 1, 1890, balance available		1,681.90
Amount appropriated by act of September 19, 1890		25,000.00
Amount available for fiscal year ending June 30, 1891		26,681.90

Amount (estimated) required for completion of existing project	330,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals for dredging in Penobscot River, Maine, between Bucksport and Winterport, opened July 2, 1889.

No.	Name and address of bidder.	Price per cubic yard. Dredged material measured in scows.	Price per cubic yard. Rocks above 1½ cubic yards each.
		Cents.	
1	Moore & Wright, Portland, Me.	24	$15.00
2	Thomas Symonds, Leominster, Mass.	35	.....
3	Robert Hamilton, Chebeague, Me., and Solomon Sawyer, Yarmouth, Me.	22	12.00
4	Joshua B. Johnson, Wilmington, Del.	17	.....

The contract was awarded to Joshua B. Johnson.

Tonnage of Penobscot River, Maine. Estimated as nearly as possible from statistics furnished for 1886.

	Arrivals.	Departures.
	Tons.	*Tons.*
Bangor	954,305	964,687
Winterport	30,000	30,000
Bucksport	45,000	41,100
Miscellaneous small landings (estimated)	50,000	50,000
Total	1,079,305	1,085,787

Total of tonnage of vessels in and out 2,165,092.

NOTE.—In the present season the shipments of ice alone will amount to 700,000 tons, which exceeds the ice shipments of 1886, by 520,087.5 tons.

A 7.

IMPROVEMENT OF HARBOR AT BELFAST, MAINE.

A project for improvement of this harbor was adopted in 1876, the object being to enable vessels drawing 10 to 12 feet of water to reach the wharves on the west side at all stages of tides.

The work was completed in 1880, leaving a small balance which has since been available, and has been partially expended in the removal of a wreck, and in necessary examinations and surveys.

The amount expended previous to June 30, 1889, was $22,213.84.

The river and harbor act of August 11, 1888, required an examination or survey of the harbor.

The examination was made in September, 1888, and a survey was made in September, 1889.

Reports of the examination and survey have been submitted and printed in Ex. Doc. No. 81, House of Representatives, Fifty-first Congress, first session.

Copies of the reports are appended hereto.

The project contemplates dredging the bar in main channel to a depth of 15 feet at mean low water and a least width of 220 feet; also dredging areas on the east and west side of the channel to 8 feet and 13 feet, respectively.

The estimated cost of the improvement is $52,000.

Congress not having taken action on this project it is not included in the statement and estimate of funds appended hereto.

The latest commercial statistics reported are included in report of Chief of Engineers for 1888, pages 383 and 384. Statistics are furnished in such form that it is very difficult to reduce them to a tonnage measurement. As nearly as this can be done, the annual tonnage in freights entering and leaving the harbor is as follows:

	Tons.
Exports	110,000
Imports	244,000

Money statement.

July 1, 1889, amount available	$2,786.16
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	800.17
July 1, 1890, balance available	1,985.99
Amount appropriated by act of September 19, 1890	10,000.00
Amount available *for fiscal year ending* June 30, 1891	11,985.99

Amount (estimated) required for completion of existing project	$42,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	42,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

A 8.

IMPROVEMENT OF HARBOR AT CAMDEN, MAINE.

This harbor is so shoal that at low water vessels drawing more than 6 feet can not reach the wharves.

The project for improvement adopted in 1888 is as follows:

(1) Dredging approaches to depth of 12 feet.

(2) Dredging channels to depth of 10 feet.

(3) Removing middle ground.

Under the appropriation of $5,000 by act of August 11, 1888, dredging was commenced August 26, 1889, and on October 3 was suspended, the small amount available having been expended.

The amount of material removed was 18,045 cubic yards, measured in scows.

The result has been to deepen the west side of the harbor and channel to grade, a distance of 1,150 feet with a width of 75 feet, and an additional distance of 905 feet with a width of 50 feet.

This is not enough to produce any radical improvement but will assist somewhat reaching wharves on the west side.

The amount removed in scows is approximately equal to 13,500 cubic yards in situ.

This would make the cost per cubic yard exceed 37 cents.

The estimated cost was 35 cents, which would doubtless exceed the actual cost if it could be done in sums not less than $20,000. In this connection attention is asked to the remarks in report for Rockport Harbor.

In such cases where a small amount is not sufficient to complete the improvement nor to make a radical benefit, it is the judgment of the officer in charge that it would be better to omit the expenditure entirely until a much larger amount may be available.

The original estimate for the entire work was $59,930. The amount already done exceeds the estimated cost of that portion. While it is hoped that future contracts may be such as to correct this small excess, yet it seems desirable to add $70 to the original estimate and thus make the amount $60,000 in round numbers.

Camden is a point touched regularly throughout the year by two or more lines of steamers, and is one of the harbors where ship-building is carried on, besides other industries.

Camden is in the collection district of Belfast. The nearest light-house is on Negro Island, at entrance to harbor.

The nearest fortification is Fort Knox, at Bucksport Narrows.

Money statement.

July 1, 1889, amount available	$4,905.14
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	4,873.81
July 1, 1890, balance available	31.33
Amount appropriated by act of September 19, 1890	6,000.00
Amount available for fiscal year ending June 30, 1891	6,031.33

Amount (estimated) required for completion of existing project	$49,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	25,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

A 9.

IMPROVEMENT OF HARBOR AT ROCKPORT, MAINE.

This harbor is upon the west side of Penobscot Bay, about 6½ miles north of Rockland. It is open on the south, and has ample depth of water except near the wharves at the upper or northern limit.

The obstructions are from the shallow water near the wharves and from ice in winter, the ice being doubtless made worse by the shallow water.

The project of improvement is to deepen the part near the upper wharves to 12 feet at mean low water.

Under the appropriation of $10,000 by act of August 11, 1888, dredging was commenced October 7, and completed December 12, 1889.

This work was under a contract with Mr. E. P. Lovering, of Portsmouth, N. H., as stated in last annual report.

Under this contract 45,000 cubic yards of material, measured in scows, were removed, resulting in deepening somewhat more than two-thirds of the area covered by the project. The remaining portion is on the west side.

This work will greatly facilitate the landing at the upper wharves, and it is hoped it may decrease the difficulty from ice in winter.

The estimated cost of the entire work was but $14,000, and it could have been completed on that sum. A little less than one-third of the work remains to be done, but a division of the small amount into two parts causes an unavoidable increase of the cost. Each part must include the transportation of dredges and scows from a distant point and return, and other contingent expenses are similarly increased. As a result the amount remaining for active work is reduced to a point which is not worth the consideration of parties controlling the best plant, and having means to do work promptly.

It is therefore often more difficult to expend such small amounts within the limits of a fiscal year than would be the case if the sums were many times as large.

A large amount of lime is shipped from Rockport, and also ice and miscellaneous articles.

Ship-building is also one of the industries.

Rockport is in the collection district of Belfast. Nearest light-house is on Indian Island at entrance to harbor.

Money statement.

July 1, 1889, amount available	$9,821.32
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	9,808.13
July 1, 1890, balance available	13.19
Amount appropriated by act of September 19, 1890	5,000.00
Amount available for fiscal year ending June 30, 1891	5,013.19

A 10.

IMPROVEMENT OF HARBOR AT ROCKLAND, MAINE.

This harbor is so located as to form a convenient refuge for large numbers of coasting vessels. It is in the southwest part of Penobscot Bay. The anchorage is good, but was originally exposed to all easterly storms.

The project for protecting the anchorage adopted in 1881 consisted of two breakwaters; the first to extend 1,900 feet from Jameson's Point, and a second breakwater nearer the shore to extend northward from South Ledge a distance of 2,640 feet. (See map opposite page 464, Report Chief of Engineers, 1881.)

In 1887 it had become apparent that it would be necessary to raise the breakwaters to high-water level and make them 20 feet wide on top. The project and estimate for the first breakwater, *i. e.*, the one from Jameson's Point, were therefore modified.

At the beginning of the fiscal year the work of increasing the height and width of the breakwater was in progress under a contract previously reported.

Work under the contract was completed December 4, 1889, and in addition thereto 584½ tons of small stone were furnished and placed in interstices, to secure the large stone, under a separate agreement with the contractor. The total of stone placed upon the breakwater under the contract was 30,073½ tons, of which 16,474½ were placed subsequent to July 1, 1889.

As a result the breakwater from Jameson's Point has been raised to level of mean high water, and 20 feet wide on top a distance of 1,235 feet from the outer end. The remaining part is 5 feet above low water and 10 feet wide on top, which is considered sufficient.

The following copies of letters and of the report of the Board of Engineers explain fully the reasons for modifying the remainder of the project for this improvement.

Total appropriations for the improvement	$152,500.00
Total expenditures to June 30, 1890	152,500.00

It is proposed to apply the funds for which an estimate is submitted to the extension of the breakwater from Jameson's Point.

Rockland is a port of considerable commercial importance and its harbor forms an excellent refuge, for which it is much used.

Rockland is a port of delivery in the collection district of Waldoborough. The nearest port of entry is Waldoborough. The nearest light-house is Owl's Head, 2 miles distant.

Money statement.

July 1, 1889, amount available	$18,162.33
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	18,162.33
Amount appropriated by act of September 19, 1890	37,500.00
Amount (estimated) required for completion of existing project	442,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	75,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

EXPORTS.

	Tons.
Lime	187,500
Fish	350
Lobsters	500

IMPORTS.

Casks	7,500
Coal	30,000
Lumber	10,000
Shingles	1,000
Clapboards	1,000
Lines of steamers	5
Arrivals of steamers	1,842

NOTE.—The statistics received are very incomplete.

LETTER FROM LIEUTENANT-COLONEL JARED A. SMITH, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Portland, Me., April 19, 1890.

GENERAL: Since the adoption of the project for improving Rockland Harbor, Maine, shown in Report of Chief of Engineers for 1881, opposite page 464, there has been much discussion of the subject, and, so far as I can ascertain, an almost unanimous opinion that the construction of the second breakwater as planned will not only injure the harbor by retaining ice in winter, but will greatly limit its benefits by the restricted room it will afford for anchorage.

These are given in connection with the opinion that an extension of the present breakwater from Jameson's Point will make the harbor as nearly as possible all that can be desired.

In 1885 Colonel Blunt, who was then in charge of the improvement, took measures to ascertain as far as practicable the facts and opinions on the subject. The replies received gave cogent reasons for continuing the improvement by extending the breakwater from Jameson's Point. The subject was first brought to my attention by Colonel Blunt, whom I succeeded early in 1886, and it has been mentioned in the annual reports since that time, but without recommendation, for the reason that the first breakwater was not completed.

The Jameson's Point breakwater has now been completed to the entire length originally planned, and with the exception of a few hundred feet near the shore the work has been raised to the level of mean high water. Nothing more is at present required upon this breakwater.

I inclose a tracing from a map of the harbor to accompany and explain this letter. Upon the tracing the breakwater now completed is shown in black. The second breakwater of original project is in red on the line of A. C.

The principal storms from which the harbor requires protection come from points between east by north and north by east. If the present breakwater be extended to a point east by north from South Ledge it will protect the wharves and inner anchorage from northeasterly storms as effectually as the proposed inner breakwater could do.

As the opening between the two breakwaters would be kept clear for a passage to the harbor, the extension of the present breakwater would protect an area for anchorage outside the 18-foot curve nearly

twice as great as would follow from the other plan. Anchorage inside the curve of 18 feet is of no practical value in storms for large vessels. It should be noticed that Jameson's Point ledge pushes the curve of 18 feet into the anchorage, and near its point has but 9.3 feet depth of water. With the smaller area Jameson's Point ledge becomes especially dangerous, and its removal would be necessary.

The available room afforded by present project is far too small to accommodate the vessels which will require the anchorage in storms.

The larger plan proposed covers a well protected area of only about 225 acres, and the best information to be obtained makes it apparent that such an anchorage will be little enough to meet the requirements. The more shallow water becomes heavily covered with ice in winter, so that the anchorage is necessarily restricted to the deep water, and it is much feared that the inner breakwater, as planned, will retain the fields of ice and assist their formation, to the great injury of the harbor.

To the reasons before given should be added the necessity for making the extremities of such breakwaters by lights of types which can not be mistaken for those of a vessel at anchor. With two breakwaters, the maintenance of two good lights will be indispensable, and a third would be desirable. With the single breakwater only one light will be needed.

In estimating the cost of the proposed extension of breakwater, it becomes necessary to revise the estimate for the inner breakwater. The estimate is for a work only 5 feet above mean low water and 10 feet wide at top. In the case of the breakwater from Jameson's Point, the height was found inadequate, so that the top has been raised to high-water level. The loose stone was so readily displaced by the action of ice and seas that the top width has been made 20 feet. It is probable, however, that a slope of one on one will be amply stable. With this modification the estimate for inner breakwater A C becomes, 462,000 tons of stone, at $1, $462,000.

Estimated cost of extending Jameson's Point Breakwater: 480,000 tons of stone, at $1, $480,000. If the extension were to be made on the line E F the estimate would become, 560,000 tons of stone, at $1, $560,000.

The difference in cost between the inner breakwater and the extension here proposed is very small, and would doubtless be quite overbalanced by the necessity for removing ledges to make more room, and by the construction and maintenance of lights.

I therefore recommend that the project for improving Rockland Harbor be modified by omitting the inner breakwater heretofore proposed, and extending the present breakwater from Jameson's Point on a continuation of its present alignment, as indicated in red, at E G on the map herewith.

Very respectfully, your obedient servant,

JARED A. SMITH,
Lieut. Col., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
April 23, 1890.

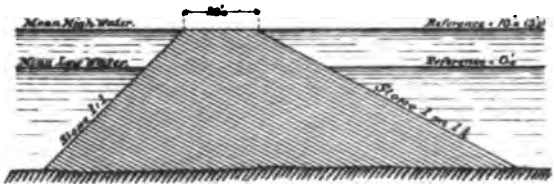
Respectfully referred to the Board of Engineers for consideration and recommendation.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

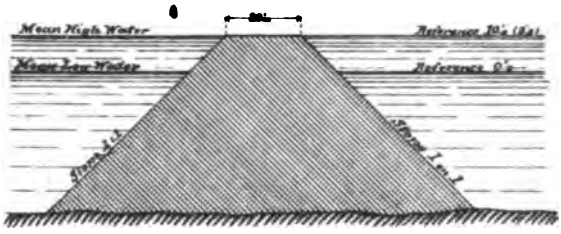
Jared A. Smith

Lt. Col. Corps of Engineers, U.S. Army.

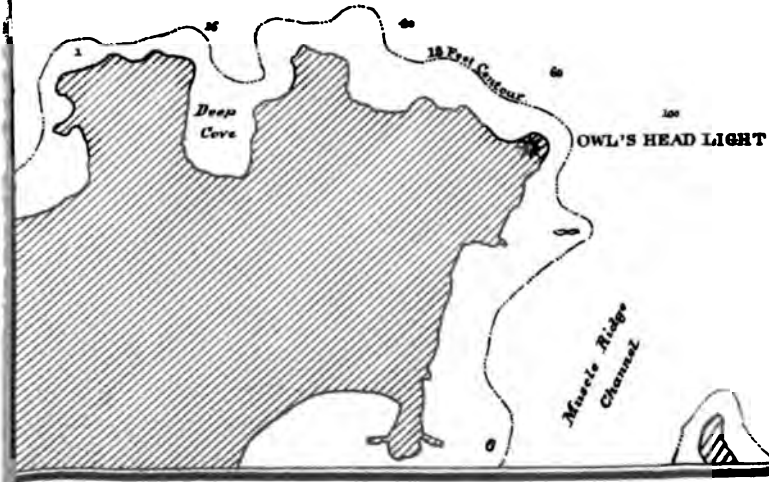
Cross Section of completed Breakwater, on Line I–II



Cross-Section of projected Extension, on Line III–IV



Scale for Cross-Sections 1:600



Eng 90

[Second indorsement.]

THE BOARD OF ENGINEERS, ARMY BUILDING,
New York City, April 25, 1890.

Respectfully returned, inviting attention to the accompanying repo of this date.

HENRY L. ABBOT,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.,
President of the Board.

[Third indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
April 28, 1890.

Respectfully submitted to the Secretary of War, with recommendation for approval, as recommended by the Board of Engineers.

THOS LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Fourth indorsement.]

Approved as recommended by the Chief of Engineers.
By order of the Secretary of War.

JOHN TWEEDALE,
Chief Clerk.

WAR DEPARTMENT,
May 2, 1890.

REPORT OF THE BOARD OF ENGINEERS.

THE BOARD OF ENGINEERS, ARMY BUILDING,
New York City, April 25, 1890.

GENERAL: The Board of Engineers has the honor to acknowledge the receipt by your indorsement of April 23, 1890, of the communication from Lieut. Col. Jared A. Smith, Corps of Engineers, dated Portland, Me., April 19, 1890, submitting a modified project for improving Rockland Harbor, Maine, and to submit the following report thereon:

In view of the large increase of harbor area to be obtained by abandoning the breakwater at South Ledge, and by confining the work to prolongation at the jetty projecting from Jameson's Point; this gain of area not being attended by great increase of cost, the Board is of opinion that the project for the harbor may be advantageously modified in these directions.

By using stone on the exterior slope of the jetty large enough not to be displaced by the waves, this slope may be made one on one, as proposed by Colonel Smith. Experience will show whether the stone obtained at Rockland at present prices will stand this slope, and if not whether greatest economy can be obtained by using a gentler slope, or by using larger stone on part of the exterior slope attacked most strongly by the waves.

In recommending the prolongation of the existing jetty from Jameson's Point the Board does not fix any definite length for it, since that should depend on the growing needs of commerce. For the purpose of estimates that proposed by Colonel Smith is as good as any. The Board with these reservations approves the abandonment of the South Ledge

Breakwater, the prolongation of the Jameson Point Jetty, and the adoption of an exterior slope for it of one on one.

Respectfully submitted.

HENRY L. ABBOT,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
President of the Board.
C. B. COMSTOCK,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.
G. L. GILLESPIE,
Lieut. Colonel of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

A 11.

IMPROVEMENT OF KENNEBEC RIVER, MAINE.

The navigation of the river is much-obstructed by shoals from Augusta to Gardiner, also near South Gardiner, and in both channels of Swan Island near Richmond; also by a ledge of rock at Lovejoy's Narrows, and by a small ledge in the harbor at Bath.

The project for the improvement consists in removing the shoals at Beef Rock, Hatch's Rock, and South Gardiner by means of wing-dams and training-walls; to remove rocks in harbor at Bath and at Lovejoy's Narrows by blasting; and to dredge the shoals from Augusta to Gardiner.

Total estimated expense of improvement	$410,500.00
Amount appropriated previous to June 30, 1890	75,000.00
Amount expended to June 30, 1890	56,838.65

As a result the contraction works at Hatch's Rock Shoal have been practically completed and the depth of water in the channel has already been so far increased as to permit the steamers from Boston to pass the shoal at low water.

So far as can be judged from this fact, the scour thus far has deepened the channel more than a foot.

The amount of material placed in these works has been 11,761 tons of stone and 1,533 fascines of brush.

The contraction works at Beef Rock Shoal, west of Swan Island, have been commenced.

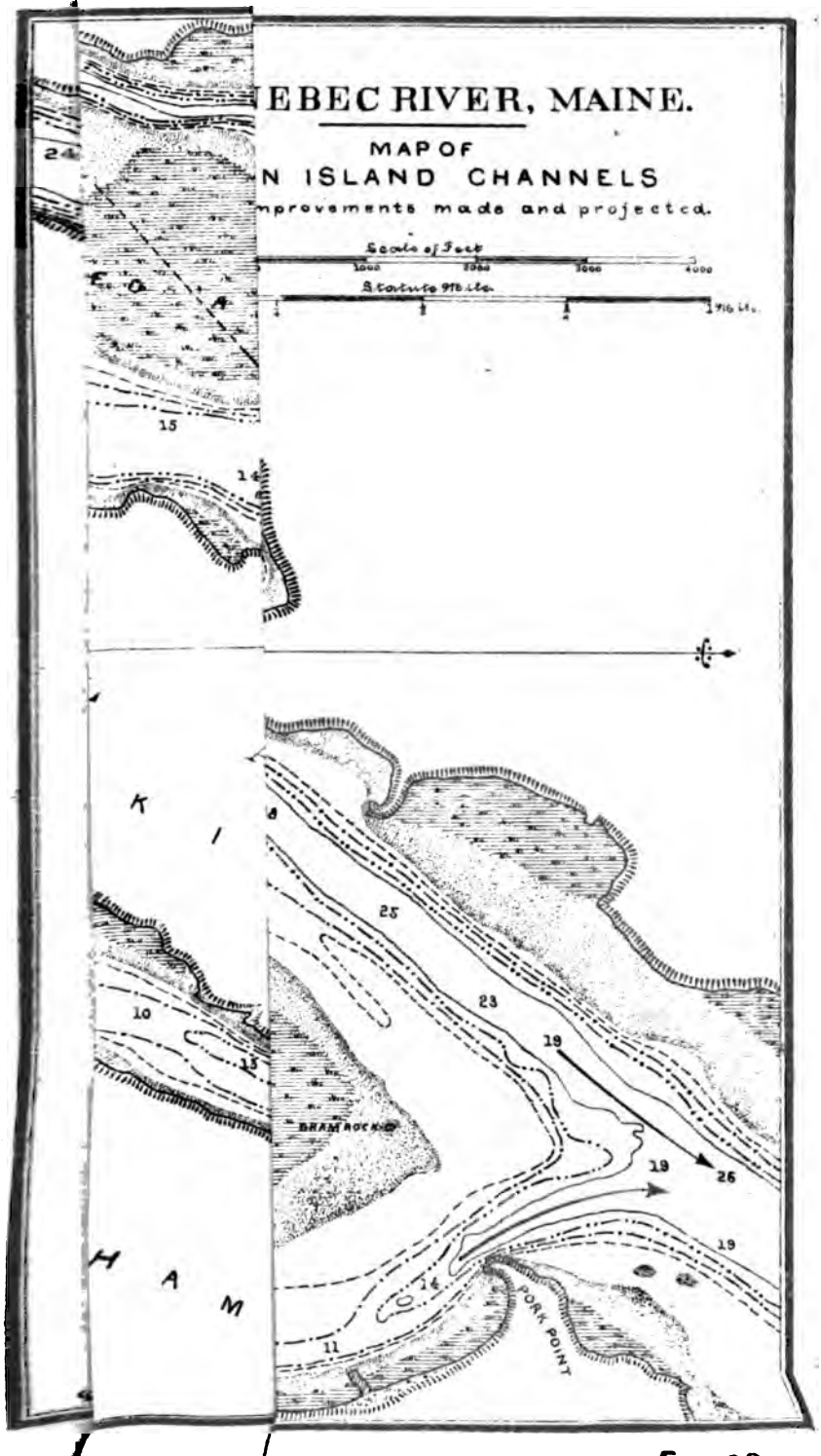
The dike across the flats has been completed a distance of 600 feet from the upper end of the training-wall; the wall itself has been raised to its full height, but to an incomplete width, over a distance of 2,010 feet, and the mattress foundation of brush has been extended and ballasted a further distance of 630 feet.

An opening was left in the old channel to permit of using the deeper water until the new one has been scoured somewhat.

The material thus far placed in this work has been 29,277 tons of stone, and 7,008 brush fascines.

The limit of time for completing work under the contract was originally made June 30, 1890, but, on application of the contractor, it has been extended two months.

The west or new channel is now very nearly as deep as the east one was before the improvement was commenced; and as the water passing through the opening is needed to perfect the new and better channel, the interval should be closed as soon as practicable.


EBEC RIVER, MAINE.
MAP OF
N ISLAND CHANNELS
mprovements made and projected.
Scale of Feet
1000
2000
3000
4000
Statute Miles
1/16 Mi.
24
15
14
K
I
H
A
M
10
15
25
23
19
19
26
19
14
11
BRAMBLE ISLAND
PORK POINT

Eng. 90

At present the opening is being reduced as far as can be done without too greatly encroaching upon the necessities of passing vessels. No noticeable scour has yet been produced in the new channel, and it can hardly be expected until the contraction work is further advanced.

The completion of the entire project will give greatly increased depths, which will be of great benefit to the numerous vessels on the river.

For the details of the project and estimate, see report of Chief of Engineers, 1888, page 421.

A small map showing both channels at Swan Island, and the plans for improving the two shoals, is forwarded to accompany this report.

The commerce of the Kennebec River is exceedingly large. In the present season the freights of ice alone will require more than 2,000 large vessels, and the granite, lumber, hay, and miscellaneous shipments will require many more, nearly all for articles exported to other States.

The inward freights are mainly for coal, provisions, and miscellaneous supplies.

The statistics obtained are necessarily incomplete.

The improvement is in the collection district of Bath. The nearest port of entry is Bath. The nearest fortification is Fort Popham, near the mouth of the Kennebec River.

The nearest light-house is Pond Island, near the mouth of the river.

Money statement.

July 1, 1889, amount available		$68,813.46
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$40,436.67	
July 1, 1890, outstanding liabilities	10,215.44	
July 1, 1890, amount covered by uncompleted contracts made during fiscal year ending June 30, 1890	17,082.39	
		67,734.50
July 1, 1890, balance available		1,078.96
Amount appropriated by act of September 19, 1890		50,000.00
Amount available for fiscal year ending June 30, 1891		51,078.96
Amount (estimated) required for completion of existing project		285,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1892		150,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Sailing Vessels.

Articles.	Tons.	Articles.	Tons.
Upward freight:		Downward freight:	
Lumber*	43,200	Lumber	194,845
Coal	120,292	Logs	211,345
Iron and steel	250	Ice	1,503,500
Ochre	400	Granite	8,873
Cement and lime	1,000	Feldspar, etc	500
Rags, wool, etc	150	Machinery	100
Rags, paper, etc	2,500	Rags, wool, etc	600
Jute	1,200	Edgings and staves	3,075
Limestone	800	Bricks	1,500
Fertilizers	1,000	Hay	3,900
Chalk	1,000		

*The lumber brought up river is principally yellow pine and oak for ship-building.

Miscellaneous freights and passengers by steamers, tonnage only given.

	Tons.
Star of the East (1,450 tons, 70 round trips Boston to Gardiner)	203,000
Kennebec (1,650 tons, 70 round trips Boston to Gardiner)	231,000
Della Collins	4,460
Islander	1,800
Total tonnage reported	2,549,240
Vessels built 39, tonnage	10,357.31
Coastwise vessels reported at Bath	5,328
Vessels entered from foreign ports	283
Vessels cleared for foreign ports	18

NOTE.—The tonnage statistics given do not include a large number of very large tow-boats, and many small boats plying regularly on the river.

A 12.

IMPROVEMENT OF PORTLAND HARBOR, MAINE.

The project for this improvement consists in dredging a channel 500 feet wide and 29 feet deep, at mean low water, from deep water of the anchorage to the lower part of the harbor, where the largest steamers and other vessels receive and discharge cargoes, and to deepen the water-front in the upper part of harbor to 16 feet.

The last-mentioned part of the project was adopted some years ago, but was only partially completed owing to questions arising regarding the projection of wharves beyond the harbor commissioner's line.

The improvement of the deep-water channel was estimated to cost $135,000.

The estimate for deepening to 16 feet is $5,000.

By acts of August 5, 1886, and August 11, 1888, the sum of $70,000 has been appropriated for this improvement.

The entire expenditures have been $68,308.23.

At the close of the last fiscal year dredging under contract had been completed.

The work thus far accomplished is the dredging of an area about 1,600 feet long, 400 feet wide, and 29 feet deep, along the front occupied by largest steamers and other vessels, and connecting this area with deep water of anchorage by a channel 2,800 feet long, 227 feet wide, and 29 feet deep.

By exercising care the largest steamers can now enter and leave the harbor or lie alongside the wharves at any ordinary low stage of the tide.

Portland is an important point, both from the commercial and military point of view.

The harbor is defended by Forts Preble, Gorges, Scammel, and a battery at Portland Head.

There is a light-house on the breakwater, and a second at Portland Head, 3 miles distant from the city.

The harbor is in the collection district of Portland and Falmouth, Me., of which Portland is the port of entry.

Money statement.

July 1, 1889, amount available	$2,754.37
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,062.60
July 1, 1890, balance available	1,691.77
Amount appropriated by act of September 19, 1890	40,000.00
Amount available for fiscal year ending June 30, 1891	41,691.77
Amount (estimated) required for completion of existing project	30,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892, Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	30,000.00

COMMERCIAL STATISTICS.

The following commercial statistics for the harbor of Portland, Me., are from a compilation by Mr. George C. Burgess, city clerk, and Mr. M. N. Rich, secretary of the board of trade:

Arrivals and departures of sailing vessels	2,895
Arrivals and departures of steamers	736
Regular lines of steamers	11
Value of imports by water	$8,656,034
Value of exports by water	4,503,061

The harbor is also used as a refuge for a very large number of vessels of all classes which are not reported.

A 13.

IMPROVEMENT OF CHANNEL IN BACK COVE, PORTLAND, MAINE.

The project for this improvement adopted in 1886 is to deepen and straighten the channel so that it shall follow the harbor commissioner's line, have a width of 300 feet and a depth of 12 feet at mean low water.

The total cost of the improvement was estimated at $180,000.

Appropriations have been made for the work as follows:

By act of August 5, 1886	$26,250.00
By act of August 11, 1888	25,000.00
The total expenditures to June 30, 1890, have been	50,974.40

At the beginning of the last fiscal year work was in progress under a contract for dredging. Work under the contract, which was limited by available funds, was completed October 11, 1889.

The amount of material dredged in the fiscal year was 74,542 cubic yards measured in scows, and the entire amount under the contract was 102,524 cubic yards.

The channel thus far dredged to grade has a length of 4,050 feet and a width of 90 feet on the bottom. In addition to the general width the upper end of the channel is widened to make a turning-basin 400 feet wide and an average length of 320 feet.

Two large wharves have been constructed at the upper end of the channel, and the development of business which was expected from the improvement has fairly begun, though it will take some years to be fully realized.

Complaints having been made regarding the draw in the bridge of the Grand Trunk Railway Company of Canada, which crosses the channel leading to Back Cove, a personal examination of the bridge was made by the officer in charge of the improvement of the channel.

At the bridge crossing the low-water channel, of 12 feet depth, is more than 700 feet wide, and that of 18 feet deep is about 400 feet wide, but the clear space through the bridge is but 39.2 feet.

The bridge crosses the channel obliquely so that the currents form an angle of about 27 degrees with the axis of the draw.

All sailing vessels are thus practically debarred from passing the draw without employing a steam-tug, and even with the tug the passage is not easy. The width of the opening is less than the beam of many vessels which might be advantageously used for freight to and from the Back Cove.

Under the provisions of section 9 of the river and harbor act of August 11, 1888, the honorable Secretary of War has taken action to secure the alteration of the draw.

A short distance above the bridge of the Grand Trunk Railroad is the highway bridge, controlled by the city of Portland. The draw-span of this bridge is less difficult to pass than the one below, but it is entirely unsuitable and should be modified.

Back Cove is a part of Portland Harbor, and is therefore in the same collection district, and is defended by the same forts, and is near the same light-houses as are given for Portland Harbor.

The commercial statistics can not at present be separated from those of the principal harbor with which they are therefore included.

Money statement.

July 1, 1889, amount available	$18,187.90
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	17,912.30
July 1, 1890, balance available	275.60
Amount appropriated by act of September 19, 1890	25,000.00
Amount available for fiscal year ending June 30, 1891	25,275.60
Amount (estimated) required for completion of existing project	103,750.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	50,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

A 14.

BREAKWATER AT MOUTH OF SACO RIVER, MAINE.

The present project for this improvement consists in repairing and completing the old breakwater, so that it shall have a height of 15 feet above low water and a width of 12 feet on top.

Estimated cost of improvement was $72,000.

Amount appropriated previous to June 30, 1890	$40,000.00
Expenditures to June 30, 1890	37,982.01

At the beginning of the fiscal year the breakwater was being enlarged and repaired by depositing stone upon it under a contract previously made.

Work has progressed very slowly, although the officer in charge of the work has used every means of urging and persuasion to secure more prompt delivery of stone.

Upon application of the contractor the limit of time for completing

the delivery of stone under the contract has been extended by the Chief of Engineers to August 1, 1890.

During the last fiscal year the amount of stone placed in the breakwater has been 10,030 tons, and the total under the contract has been 10,134 tons.

The repair and enlargement of the breakwater has been extended about 800 feet, making a total distance, from the outer end, of 2,100 feet, besides a further extension of about 200 feet partially done.

The completion of the project is desirable, but it is not at present as much needed as other works for improving the channel of the river.

In this connection attention is invited to remarks in last annual report upon Saco River improvement, pages 535 and 536, Report of Chief of Engineers, 1889.

Commercial statistics for the improvement are included with those for the improvement of Saco River.

The breakwater is in the collection district of Saco. The nearest port of entry is Saco. The nearest light-house is Wood Island Station.

Money statement.

July 1, 1889, amount available		$12,143.86
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$7,280.10	
July 1, 1890, outstanding liabilities	2,845.77	
July 1, 1890, amount covered by uncompleted contracts made during the fiscal year ending June 30, 1890	1,700.00	
		11,825.87
July 1, 1890, balance available		317.99
Amount appropriated by act of September 19, 1890.*		

A 15.

IMPROVEMENT OF SACO RIVER, MAINE.

The project for improving the Saco River includes the works considered necessary to give a channel, having not less than 6 feet depth at low water to the cities of Saco and Biddeford. The channel was obstructed by a bar, by shoals, and in one place by a ledge, and does not afford a continuous depth exceeding 3½ feet at low water, though much of the channel is deeper. The works were mentioned in detail in last annual report, page 535, Report of Chief of Engineers, 1889.

Total estimated cost	$155,000.00
Amount appropriated previous to June 30, 1890	22,500.00
Expenditures to June 30, 1890	20,978.99

Work under the contract reported last year is not finished. The contractor has been exceedingly dilatory, notwithstanding the constant efforts of the officer in charge to obtain more prompt results.

The wing-dam and training-wall at Little Islands have been practically completed, though some small amounts of stone may still be required where the stone has settled.

* The amount appropriated for this work in act of September 19, 1890, is included in the appropriation for Saco River. See report on Saco River, page 447.

The part of wing-dam at Cow Island, which forms the protection to the island itself, has been constructed.

The total amount of stone delivered and placed during the year has been but 3,185 tons, a total of 7,826 tons thus far under this contract. Upon the application of the contractor the Chief of Engineers has extended the time for completing the delivery of stone under the contract until September 1, 1890.

Regarding the prosecution of these works I respectfully ask attention to the remarks and recommendations in last annual report. (Report Chief of Engineers, 1889, pages 535, 536.)

Saco River is in the collection district of Saco, Me., of which Saco is the port of entry. Nearest light-house, Wood Island,

Money statement.

July 1, 1889, amount available		$4,986.57
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$3,064.73	
July 1, 1890, outstanding liabilities	400.83	
July 1, 1890, amount covered by uncompleted contracts made during fiscal year ending June 30, 1890	1,521.01	
		4,986.57
Amount appropriated by act of September 19, 1890. (Including breakwater at the mouth of Saco River)		65,000.00
Amount (estimated) required for completion of existing project		97,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1892		50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

COMMERCIAL STATISTICS.

The following statistics for the year 1889 were kindly furnished by G. N. Weymouth, secretary of the Biddeford Board of Trade.

IMPORTS.

	Tons.
Lime	787½
Cement	315
Pine lumber	20,000
Iron	4,000
Cotton	1,500
Molding sand	2,000
Gravel, etc	2,000
Total	30,602½

EXPORTS.

Bricks	6,250
Ice	10,000
Granite	20,000
Total	36,250
Total tonnage	66,852½

The following statistics for the fiscal year ending June 30, 1890, were furnished by the collector of customs.

No arrivals of vessels from foreign ports. Three clearances for foreign ports.

No record is kept of arrivals or clearances coastwise.

The following additional statistics for the year ending June 30, 1890, have been obtained by the United States engineer inspector:

Number of arrivals of sailing vessels at Saco and Biddeford, 239.

Imports:		
Coal	tons..	44,412
Exports:		
Sand	tons..	3,685
Tonnage, up stream		75,014½
Tonnage, down stream		39,935
Total tonnage		114,945½

A 16.

IMPROVEMENT OF KENNEBUNK RIVER, MAINE.

During the last fiscal year some small expenses have been incurred in making a chart of the river, and obtaining deeds to lands belonging to the United States.

Total expenditure in year, $76.62.

Under requirements of the river and harbor act of August 11, 1888, an examination of the river was made in December, 1888, and in the summer of 1889 the old piers and grounds were surveyed.

The reports were printed in House Ex. Doc. No. 136, Fifty-first Congress, first session. See Appendix.

The amount estimated to repair the piers and construct one small jetty is $20,000.

The river is in the collection district of Kennebunk; nearest port of entry is Kennebunk; nearest light-house is on Goat Island near Cape Porpoise.

Money statement.

July 1, 1889, amount available	$76.62
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	76.62
Amount appropriated by act of September 19, 1890	20,000.00

COMMERCIAL STATISTICS.

The following statistics for the year 1889 were kindly furnished by the Hon. John W. Deering:

RECEIPTS BY WATER.

	Tons.
Coal	7,000
Lumber	500
Total tonnage of freight	7,500

NOTE.—The place is also visited by numerous steam tugs, small sailing vessels and pleasure craft.

The following commercial statistics for the year ending June 30, 1890, were furnished by the collector of customs:

Shipping.	Number.	Tonnage.
Arrivals from foreign ports	1	85.00
Clearances from foreign ports	2	629.75
Vessels building and under contract	4	3,550.00

The part of wing-dam at Cow Island, which forms the protection to the island itself, has been constructed.

The total amount of stone delivered and placed during the year has been but 3,185 tons, a total of 7,826 tons thus far under this contract. Upon the application of the contractor the Chief of Engineers has extended the time for completing the delivery of stone under the contract until September 1, 1890.

Regarding the prosecution of these works I respectfully ask attention to the remarks and recommendations in last annual report. (Report Chief of Engineers, 1889, pages 535, 536.)

Saco River is in the collection district of Saco, Me., of which Saco is the port of entry. Nearest light-house, Wood Island,

Money statement.

July 1, 1889, amount available		$4,986.57
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$3,064.73	
July 1, 1890, outstanding liabilities	400.83	
July 1, 1890, amount covered by uncompleted contracts made during fiscal year ending June 30, 1890	1,521.01	
		4,986.57
Amount appropriated by act of September 19, 1890. (Including breakwater at the mouth of Saco River)		65,000.00
Amount (estimated) required for completion of existing project		97,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1892		50,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

The following statistics for the year 1889 were kindly furnished by G. N. Weymouth, secretary of the Biddeford Board of Trade.

IMPORTS.

	Tons.
Lime	787½
Cement	315
Pine lumber	20,000
Iron	4,000
Cotton	1,500
Molding sand	2,000
Gravel, etc	2,000
Total	30,602½

EXPORTS.

Bricks	6,250
Ice	10,000
Granite	20,000
Total	36,250
Total tonnage	66,852½

The following statistics for the fiscal year ending June 30, 1890, were furnished by the collector of customs.

No arrivals of vessels from foreign ports. Three clearances for foreign ports.

No record is kept of arrivals or clearances coastwise.

The following additional statistics for the year ending June 30, 1890, have been obtained by the United States engineer inspector:

Number of arrivals of sailing vessels at Saco and Biddeford, 239.

Imports:		
Coal	tons..	44,412
Exports:		
Sand	tons..	3,685
Tonnage, up stream		75,014½
Tonnage, down stream		39,935
Total tonnage		114,945½

A 16.

IMPROVEMENT OF KENNEBUNK RIVER, MAINE.

During the last fiscal year some small expenses have been incurred in making a chart of the river, and obtaining deeds to lands belonging to the United States.

Total expenditure in year, $76.62.

Under requirements of the river and harbor act of August 11, 1888, an examination of the river was made in December, 1888, and in the summer of 1889 the old piers and grounds were surveyed.

The reports were printed in House Ex. Doc. No. 136, Fifty-first Congress, first session. See Appendix.

The amount estimated to repair the piers and construct one small jetty is $20,000.

The river is in the collection district of Kennebunk; nearest port of entry is Kennebunk; nearest light-house is on Goat Island near Cape Porpoise.

Money statement.

July 1, 1889, amount available	$76.62
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	76.62
Amount appropriated by act of September 19, 1890	20,000.00

COMMERCIAL STATISTICS.

The following statistics for the year 1889 were kindly furnished by the Hon. John W. Deering:

RECEIPTS BY WATER.

	Tons.
Coal	7,000
Lumber	500
Total tonnage of freight	7,500

NOTE.—The place is also visited by numerous steam tugs, small sailing vessels and pleasure craft.

The following commercial statistics for the year ending June 30, 1890, were furnished by the collector of customs:

Shipping.	Number.	Tonnage.
Arrivals from foreign ports	1	85.00
Clearances from foreign ports	2	629.75
Vessels building and under contract	4	3,550.00

A 17.

IMPROVEMENT OF HARBOR AT YORK, MAINE.

The entrance to this harbor is in a narrow bend where the channel depth between the contours of 10 feet at mean low water was not more than 75 feet wide.

Two other points above the narrows are also in bends where the channel is narrow, and at all the points the tidal currents are very rapid.

The object of the project for improvement is to give greater width at the narrow points, and to somewhat reduce the effect of the strong currents.

The total of appropriations for the work is $25,000.

Expenditures to June 30, 1890, $16,528.90.

A contract for removing the ledge and overlying material of sand, gravel, and bowlders was executed previous to the last report.

Work under the contract was commenced September 26, 1889, and continued until October 31, when it was suspended for the winter. Drilling and blasting of the ledge was commenced early in April and continued to the close of the year.

Various causes have combined to delay the contractor, and an extension of time until September 30, 1890, has been granted on the contract.

The amount of material removed in the last year has been: Of sand, gravel, and bowlders, 1,210.1 cubic yards; of solid ledge, 214.7 cubic yards

It is proposed to expend the balance on hand, and the funds for which the estimate is submitted, first in completing the removal of the point at Stage Neck, and second the points above.

The improvement is in the collection district of York.
Nearest light-house is Cape Neddick, 3 miles distant.

Money statement.

July 1, 1889, amount available		$11,778.17
July 1, 1890, amount expended during fiscal year exclusive of liabilities outstanding July 1, 1889	$1,050.47	
July 1, 1890, outstanding liabilities	2,256.60	
July 1, 1890, amount covered by uncompleted contracts made during fiscal year ending June 30, 1890	7,965.45	
		11,272.52
July 1, 1890, balance available		505.65
Amount appropriated by act of September 19, 1890		10,000.00
Amount available for fiscal year ending June 30, 1891		10,505.65
Amount (estimated) required for completion of existing project		9,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892		9,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

A 18.

IMPROVEMENT OF HARBOR AT PORTSMOUTH, NEW HAMPSHIRE.

The project for improving this harbor was adopted in 1879, the object *being to check* the strong tidal currents which were injurious to navi-

gation, and to give a navigable depth over the ledge known as Gangway Rock opposite to the navy-yard.

The only part remaining to complete the work as designed is the removal of part of the ledge on point of Badger's Island.

The expense of removing any considerable amount is considered to be far too great for any benefits which will follow.

For reasons set forth in previous reports no further work is recommended save the removal of the extreme point to a depth of 18 feet, as far as it may be done with funds now available.

In the summer of 1889, work under the contract previously reported was carried on until November 15, drilling and blasting the ledge, but as no rock was removed no payments were made.

In the spring of 1890 work was resumed April 9, removing the rock which had been previously blasted. Work was continued throughout the month of May, when it was suspended temporarily.

A considerable quantity of loose rock was cleared away and placed upon the breakwater, but the area cleared to grade of 18 feet below low water was only such as to permit payment for 168 cubic yards.

The limit of time for completing the work under the contract was originally December 31, 1889; this has been extended to September 30, 1890.

The contractor has worked very faithfully and diligently upon this work, but it is a very hard rock in a very bad situation for convenient work, and in the midst of extraordinary tidal currents.

Portsmouth is a port of entry. The light-houses are the harbor light at Fort Constitution, and Whales Back at the entrance.

The defenses of the harbor are all incomplete works; Fort Constitution and an open battery on the west side, and Fort McClary and an open battery on the east side.

The navy-yard at Kittery, Me., is on the east side of the harbor.

Money statement.

July 1, 1889, amount available		$14,320.86
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$2,206.66	
July 1, 1890, outstanding liabilities	184.80	
July 1, 1890, amount covered by uncompleted contracts made during fiscal year ending June 30, 1890	11,637.96	
		14,029.42
July 1, 1890, balance available		291.44
Amount appropriated by act of September 19, 1890		13,000.00
Amount available for fiscal year ending June 30, 1891		13,291.44

COMMERCIAL STATISTICS.

The following commercial statistics for the year 1889 were courteously furnished by Col. William H. Sise, president of the Board of Trade:

Arrivals of steamers	41
Net tonnage	33,956
Arrivals of sailing vessels	741
Net tonnage	164,460

The above are exclusive of Government vessels to and from navy-yard, of four lines of small steamers and 5 tow-boats.

Vessels owned in Portsmouth	63
Tonnage	10,198.87

IMPORTS.

	Tons.
Coal	300,667
Railroad ties	17,500
Lumber	8,886
Wood	742
Lime, etc	721
Salt	927
Sand	2,038
Stone	684
Iron	2,429
Water pipe	348
Potatoes	60
Oysters	175
Lobsters	200
Phosphate	287
Merchandise	1,500

EXPORTS.

Bricks	36,875
Total tonnage	373,039

A 19.

IMPROVEMENT OF BELLAMY RIVER, NEW HAMPSHIRE.

The river to the head of navigation is a tidal branch of Great Bay, which opens into the Piscataqua River at Dover Point, 4 miles above the bridge at Portsmouth, N. H.

At low water the channel of the river was too shallow for any navigation save for a short distance. The entire distance over which improvements are required is 13,000 feet, a little more than 2½ miles. The project of improvement consists simply in dredging the present natural channel sufficiently to give a mean low-water depth of 5 feet and a width of 50 feet on the bottom. The depth at mean high water will be nearly 12 feet.

The improvement commences at a point about 2 miles from the Piscataqua River.

The contract which was outstanding at last report was completed August 31, 1889.

The amount dredged in July and August was 21,650 cubic yards, and the total under the contract which was begun May 1 was 44,350 cubic yards.

As a result the deepened channel has been extended 4,950 feet, more than one-third the entire distance to be improved.

Large vessels can now ascend nearly 3 miles from Dover Point Bridge.

The benefits to be expected from this small improvement are mainly in the expense of freighting bricks and a consequent increase in manufacture. A very large amount of the finest quality of bricks are made on and near the banks of this river.

The partial improvement has had no time to develop any material changes in tonnage or freight rates, such as are expected from the entire work.

The total expenditures to June 30, 1890, have been $10,000.

Money statement.

July 1, 1889, amount available	$4,794.67
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	4,794.67
Amount appropriated by act of September 19, 1890	10,000.00
Amount (estimated) required for completion of existing project	8,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	8,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

A 20.

IMPROVEMENT OF THE COCHECO RIVER, NEW HAMPSHIRE.

A description of this river was given in Annual Report for 1887, and a map showing its connections with the Piscataqua River. (Report Chief of Engineers 1887, page 548.)

The river was originally so much obstructed by a ledge of rock and by bowlders, logs, sand, etc., as to be practically useless for commercial navigation.

The improvements which were completed in 1889 gave a channel having a mean low-water depth of 5 feet and a mean high-water depth of nearly 12 feet. The narrowest places of the channel are in the ledge of rock where the clear width is but 40 feet and not 50 feet, as given by an error in the last Annual Report.

As a result of the improved channel the navigation has increased from year to year until in 1888—the last complete reports obtained—the number of loaded vessels going to Dover was 131, having an average freight of 300 tons each, about 40,000 tons in all.

The saving of expense in freights resulting from this improvement can hardly be less than $1 per ton, besides an incidental benefit upon many articles not brought by water.

Under the provision of section 13 of the river and harbor act of August 11, 1888, an examination and survey of the river has been made; the final report was submitted December 14, 1889, and was printed House Ex. Doc. No. 74, Fifty-first Congress, first session. A copy is appended hereto.

The small balance of funds on hand June 30, 1889, has been expended upon the survey.

Money statement.

July 1, 1889, amount available	$290.28
July 1, 1890, amount expended during fiscal year, exclusive of liabilites outstanding July 1, 1889	290.28
Amount appropriated by act of September 19, 1890	25,000.00
Amount (estimated) required for completion of existing project	150,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	75,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

A 21.

HARBOR OF REFUGE AT LITTLE HARBOR, NEW HAMPSHIRE.

The project for this improvement, adopted in 1888, consists of two small breakwaters at the entrance to the harbor and dredging the channel and enlarged anchorage to a depth of 12 feet at low water.

Little Harbor is a part of the mouth of the Piscataqua River, or rather the mouth of a minor channel of the river, which is separated from the main channel by Great Island and Goat Island.

The extraordinarily strong currents of the river are confined to the main channel; these currents are so strong that a sailing vessel can make no headway against them except with a strong fair wind.

In the storms, which cause danger on that part of the coast, it is impossible for a sailing vessel to enter Portsmouth Harbor against the ebb tide, a fact which has caused the loss of many vessels and some lives. A life-saving station has therefore been established at Little Harbor.

Little Harbor is so situated as to make a safe and convenient refuge at the times when vessels can not enter the main channel of the river.

At the end of the last fiscal year a contract was outstanding for dredging the channel and anchorage to a depth of 9 feet.

Work under the contract was satisfactorily completed July 31, 1889.

The amount of material removed in July, 1889, was 27,000 cubic yards, making a total of 64,479 cubic yards removed under the contract.

The resulting channel is 100 feet wide and more than 3,000 feet long to the inner anchorage, which has been widened to 300 feet. The present depth is but 9 feet at mean low water.

Total expenditures to June 30, 1890, $30,000.

There are no definite commercial statistics for this harbor, as it is essentially a refuge for all vessels which enter the Piscataqua River, as well as for some coasters.

As a result of the improvement, however, small steamers have made irregular trips to the landing and a regular passenger steamer has now been provided to run to and from that place during the summer season.

NOTE.—For local commercial statistics see Portsmouth Harbor, Cocheco, and Bellamy rivers.

Money statement.

July 1, 1889, amount available	$8,674.01
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	8,674.01
Amount appropriated by act of September 19, 1890	40,000.00
Amount (estimated) required for completion of existing project	165,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	100,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

A 22.

PRELIMINARY EXAMINATION OF BELFAST HARBOR, MAINE.

UNITED STATES ENGINEER OFFICE,
Portland, Me., January 3, 1889.

SIR: In compliance with instructions from the Chief of Engineers, U. S. Army, in letters dated August 28, 1888, and September 29, 1888, I have visited Belfast Harbor, Maine, and have the honor to submit the following preliminary report:

The city and harbor of Belfast are so well known that a description seems superfluous. Belfast is a port of entry, located upon the northeastern part of Penobscot Bay. A large area of the surrounding country is dependent upon Belfast as receiving and shipping port.

A report upon the necessity for the further improvement of Belfast Harbor was submitted February 2, 1888, and was printed in Report of Chief of Engineers for 1888, page 381, to which I would refer.

The more recent examination which I made on the 12th of December, 1888, brought out some points which had not before been obtained.

The commercial statistics of Belfast Harbor, which were included in my last annual report, are sufficient to show the general importance of the place, and to justify a statement that the harbor is worthy of improvement by the United States. (See Report of Chief of Engineers, 1888, pp. 383 and 384.)

The agent of the Boston line of steamers informed me that the steamers had great difficulty in landing at low water, and he pointed out several places where the depth of water is apparently less than formerly.

The agent of the New York steamers gave essentially the same information, and though it did not in all respects conform to what I had been told on a former occasion, yet I was convinced that some further improvements are necessary in the interest of navigation and commerce.

The work for which an estimate of $15,600 was submitted in my report of February 2, 1888, will doubtless cover all that is required in the northeast side of the harbor, but the amount which may be required in the channel, or in the southwest side, can only be estimated after a survey shall have been made.

I recommend that a survey of the harbor be made sufficiently in detail to indicate fully all the requirements; the survey to include examinations of the character of the bottom.

The estimated expense of making such a survey with the subsequent platting of maps and making plans and estimates is $800.

Very respectfully, your obedient servant,

JARED A. SMITH,
Lieut. Col., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

SURVEY OF BELFAST HARBOR, MAINE.

UNITED STATES ENGINEER OFFICE,
Portland, Me., December 20, 1889.

GENERAL: I have the honor to submit the following report of a survey of Belfast Harbor, Maine, made in accordance with requirements

of section 13 of river and harbor act of August 11, 1888, and instructions contained in Department letter of April 1, 1889.

The small surveys, of which several were assigned to my charge, were none of them of sufficient extent to justify the employment of any assistants in addition to those regularly engaged upon works in charge of this office. It was, therefore, not until September, 1889, that an assistant engineer could be spared from other duties for this purpose.

In September, 1889, Mr. A. C. Both, U. S. assistant engineer, was directed to make a complete hydrographic survey of Belfast Harbor and to make such further examination as might indicate the nature and extent of improvements which are necessary.

Mr. Both's report, to which I invite attention, is appended hereto.

A tracing from the map which has been platted is forwarded in a separate package to accompany this report.

The material in the bottom of the harbor is generally soft, and in no place where improvements are proposed is it too hard to be removed by dredging.

A comparison of maps made at different dates indicates that no perceptible filling occurs in the harbor, so that greater depths procured by dredging will be retained for a very long time, if not permanently.

It is proposed to dredge the central channel to a depth of 15 feet at mean low water; to dredge an area on the west side to a depth of 13 feet, and an area on the east side to a depth of 8 feet.

The mean rise of tides above mean low water is 9.7 feet. The depth in the channel at high water would therefore be 24.7 feet, while in the other areas the high-water depths would be 22.7 feet and 17.7 feet respectively.

These depths will greatly increase the facilities for business at Belfast, and I believe they will be sufficient.

My preliminary report, submitted January 3, 1889, refers to the commercial features of Belfast Harbor, so that no further discussion of the subject is necessary at this time.

Very respectfully, your obedient servant,

JARED A. SMITH,
Lieut. Col. Corps of Engineers.

BRIG. GEN. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. A. C. BOTH, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Portland, Me., December 16, 1889.

COLONEL: I have the honor to report upon the survey of Belfast Harbor, Maine, made under your direction, in compliance with a requirement in the river and harbor act of August, 1888.

The survey was commenced September 18 and completed September 28, 1889. A number of the triangulation points of a former survey of this harbor, made by me in 1875, having since been obliterated, it was necessary to establish some new points.

Two old stations, viz: XII (Patterson's Point), and D (near McGilvery's ship-yard), which were marked by drill holes in rock, were used as starting points, and a number of new points were established on both sides of the harbor. Some small additions to wharves on the west side, and a new wharf and ice-house built on the east side, near the mouth of Goose River, have been embodied in this survey.

The map of the survey, drawn to a scale of 1 : 3000 (same scale as map of survey of 1875), is herewith submitted. The reference for soundings shown on this map is mean low water, same as for survey of 1875, and the mean rise and fall of tides is *9.7 feet.*

A comparison of the soundings shown on this map with those formerly made clearly indicates that no perceptible changes of the bottom of the harbor have taken place. The depths over the area in front and below the Boston and Bangor steamer wharf, formerly dredged to 12 feet at mean low water, and from the upper end of said wharf to Lane's Wharf to 10 feet at mean low water, have not changed materially. The shoal ground which appears outside or easterly of the improved areas was not dredged at that time, it being presumed, owing to the very soft character of the material forming these shoals, that they would wash away or level down. This, however, has not been the case, and the soundings of the two surveys on these shoals are in a practical sense identical. From the fact that during an interval of fourteen years no material changes have taken place in Belfast Harbor, the conclusion can safely be drawn that improvements here made and projected may be considered permanent.

The improvements which are recommended are believed to fully subserve the needs of navigation carried on in Belfast Harbor, and are as follows, viz:

(1) Dredging the main channel, marked "A," leading from deep water to the upper harbor to a depth of 15 feet at mean low water and a least width of 220 feet, the average length being about 2,000 feet.

(2) Dredging the area marked "B" to a depth of 8 feet at mean low water; area averages 350 feet in width and 900 feet in length.

(3) Dredging area marked "C" to a depth of 13 feet at mean low water; this area averages 700 feet in width and 1,950 feet in length.

Owing to the general increase in tonnage and draught of coasting vessels, the depths of water now available are insufficient, and great inconvenience and frequent delays are caused thereby, especially to the passenger steamers which run on time.

The steamers of the following lines make landings here at various hours: Bangor and Boston Steam-ship Line, Bangor and Rockland Steam-boat Line, Belfast and Castine Steam-boat Line, Bangor and Mt. Desert Steamboat Line, Bangor and New York Steam-ship Line.

The last steamer plies between Bangor and New York, carrying freight and passengers. It is a large iron propellor, making her handings at Lewis's Wharf, in the upper part of the harbor. As by far the greater part of all the large vessels entering the harbor also load or discharge at the wharves in this part of the harbor, a channel with ample depth and width must be considered a necessity.

A large and growing ice industry is carried on on the east side of the harbor, and many vessels are loaded here annually. Increased facilities for the movements of vessels at this place seem to be very much needed.

To facilitate the movements of the steamers the area marked "C" should be dredged throughout to the proposed depth of 13 feet at mean low water.

The draught of the new large steamers of the Boston and Bangor Line being greater than formerly, very frequently at low tides they run aground, causing vexatious delays. The fact also that this area was not wholly dredged over to 12 feet of water at the time the former improvements were made, and shoals with only about 10 feet of water lie now in front of the wharf makes an increase of the depth to 13 feet at mean low water a necessity.

ESTIMATED COST OF IMPROVEMENT:

(1) Dredging channel marked "A" from deep water to the upper harbor 220 feet wide and 15 feet deep at mean low water will require the removal of 70,324 cubic yards, measured in scows, at 20 cents per cubic yard	$14,064.80
(2) Dredging area marked "B" to a depth of 8 feet at mean low water will require the removal of 50,521 cubic yards, measured in scows, at 20 cents per cubic yard	10,104.20
(3) Dredging area marked "C" to a depth of 13 feet at mean low water will require the removal of 111,669 cubic yards, measured in scows, at 20 cents per cubic yard	22,333.80
	46,502.80
Engineering expenses and contingencies	5,497.20
Total cost of improvements	52,000.00

Very respectfully, your obedient servant,

A. C. BOTH,
Assistant Engineer.

Lieut. Col. JARED A. SMITH,
Corps of Engineers, U. S. A.

A 23.

PRELIMINARY EXAMINATION OF UNION RIVER AND UNION RIVER BAY, MAINE.

UNITED STATES ENGINEER OFFICE,
Portland, Me., November 30, 1888.

SIR: In accordance with instructions from the Chief of Engineers in letter dated August 28, 1888, I have to submit the following report of a preliminary examination of the Union River, and Union Bay, Maine.

On the 16th of October I visited the river and in company with two regular pilots in a small boat went over the part where the obstructions are found.

To describe the situation a brief history is necessary.

About seventeen years ago the channel of the river was quite thoroughly improved under appropriations as follows:

By act of Congress approved July 11, 1870	$15,000
By act of Congress approved March 3, 1871	15,000
Total	30,000

There were removed from the channel about 80,000 cubic yards of slabs, edgings, and other refuse of saw-mills, besides a large quantity of rock in ledge and bowlders.

A good channel was made affording a depth of 3 to 4 feet at mean low water and 15 feet at ordinary high water. (Report Chief of Engineers 1872, page 928.)

The mill refuse thus removed was only a small portion which had lodged between the river banks.

The saw-mills, which have been the cause of most of the trouble, are located upon the river above the head of navigation, and much of the material thrown into the stream is washed down to the navigable channel where it sinks and becomes imbedded with mud and sand.

There is a large amount of mill waste in the river above the dam, and occasionally masses break away in freshets and are lodged below. I was informed that in a freshet two years ago last spring the vast quantity of water-logged slabs, edgings, shavings, etc., which came over the dam, added to what was already below, formed a jam entirely across the channel, and when it finally broke through, the opening was in a different place from the former channel. All the difficulty in the river proper is within 1½ miles from the head of navigation, the upper half mile of which forms the harbor of Ellsworth.

I thrust down an iron-pointed pole in many places within the distance obstructed, and in every instance the iron point stuck into wood.

The examination was made at low water; a large portion of the area between the river banks was seen to be a tangled mass of slabs, sticks, shavings, sawdust, and dirt, entirely above low-water level. These wooden shoals change from year to year and make the low-water channel very crooked and shallow.

A steam saw-mill located on the wharves apparently consumes all its waste, but the mills above, which are driven by water-power, make but very little effort to keep sawdust and all small waste out of the river.

I visited one of the mills at the dam, perhaps half a mile above the head of navigation, and found a flume carrying a strong current of water under the mill with chutes leading into it, carrying off the waste. The water in the river was full of sawdust and strewn with floating wood. On every obstruction, at the banks, or in the stream, piles of

sticks and other waste were lodged. A large mass of slabs below the mills, on each side of the river, was on fire, indicating that some care is now taken to keep the slabs out of the channel.

Of course the channel dredged seventeen years ago has no trace of its location left, and it is equally evident that were a new channel to be dredged it would not remain long while present conditions exist.

Even were the dumping of mill waste into the river to be stopped, it is probable that the amount now in the stream above as well as below the dam, would be sufficient to renew the obstruction from time to time.

About 3 miles below Ellsworth the river becomes very broad and forms what may properly be called the head of Union River Bay. This wide part of the river, or upper part of Union River Bay, is more than a mile long and has an average width of more than half a mile. The slackened currents due to the increased width, have allowed the mill waste to form an extensive deposit.

The upper part of Union River Bay, which forms the mouth of Union River, is very shallow at low water, having been so much filled with mill waste as to destroy the anchorage, which is said to have once been good, and to form an extensive bar.

The Coast Survey charts indicate that the bar is of sawdust, though it doubtless contains edgings, bark, and slabs.

At average high water vessels drawing 12 feet or perhaps a little more can get over the bar. The Coast Survey charts give 10 feet as the mean rise and fall of tides.

Although the sawdust and small sticks, when soaked with water, are sufficiently heavy to sink where the current is not rapid, yet when disturbed, such material is difficult to maintain in place; it is very baffling and consequently expensive to dredge.

About seventeen years ago the mouth of the river was improved by removing ledges and bowlders, and it is probable that an improvement of the river and bar would involve some further removal of stone.

A channel dredged through such a bar can not be considered a permanent improvement unless protected in such a manner as to retain the banks and to prevent further lodgment of material by increasing the current in the cut.

A permanent improvement to the channel in the river and bay would therefore be somewhat expensive.

Ellsworth, at the head of navigation on Union River, has a population of a little more than 5,000. A branch of the Main Central Railroad passes through the town. The place is central to a considerable section of country for which it is a base of supplies.

A list of vessels visiting Ellsworth for the current season shows that the navigation of the river, even in its present condition, is quite extensive.

The list may be condensed as follows:

First—Coasting vessels running to New York.

Number of different vessels		27
Largest tonnage	tons	216
Smallest tonnage	do	82
Total registered tonnage	do	3,183
Greatest draught	feet	13
Least draught	do	9

These vessels all made six or more trips except one which made but five.

The total registered tonnage for all the trips to Ellsworth amounted to 19,759 tons.

Freights are usually very much greater than the measured and registered tonnage.

Second—Coasting vessels running to Boston, etc.		
Number of different vessels		28
Largest tonnage registered	tons	250
Smallest tonnage registered	do	50
Total tonnage registered	do	2,271
Draught	feet	8 to 11
Trips of each, greatest number		16
Trips of each, least number		8
Tonnage for total of trips	tons	18,308
Smaller coasting vessels:		
Number of vessels		11
Total tonnage	tons	385
Number of trips of each		10 to 25
Total tonnage for all trips	tons	7,229
Miscellaneous, other vessels		20
Total tonnage	tons	600
Average trips		3
Total for all trips	tons	1,800

RECAPITULATION.

Total number of vessels		69
Total registered tonnage	tons	6,437
Total number entrances and clearances		682
Total tonnage for all entries, etc	tons	47,090

The following list gives approximately the shipments by water of some of the principal articles of freight during one year past:

Staves	number	40,000,000
Barrel heads	pieces	240,000,000
Long lumber, board measure	feet	25,000,000
Shingles	number	20,000,000
Laths	do	12,500,000
Wood	cords	5,000
Brick	number	1,000,000

The navigation of Union River and Union River Bay is sufficient in my opinion to make them worthy of improvement.

In order, however, that the situation may be understood, it should be remembered that the process of filling the river with sawdust, bark-edgings, etc., is still going on; the waste is thrown in above the point where the river is navigable, and therefore seems to be beyond the control of the United States. The State laws are entirely inadequate to fully stop the difficulty even if the laws were enforced.

While the State, town, and individuals permit the continued disposal of mill waste as described, and also the dumping of miscellaneous rubbish into the river, I can not feel justified in submitting a recommendation that the United States shall clear it away.

A survey in sufficient detail to form a definite basis for plans and estimates will cost $600.

Very respectfully, your obedient servant,

JARED A. SMITH,
Lieut. Col., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

SURVEY OF UNION RIVER AND UNION RIVER BAY, MAINE.

UNITED STATES ENGINEER OFFICE,
Portland, Me., January 11, 1890.

GENERAL: I have the honor to submit the following report of a survey of the Union River, and Union River Bay, Maine.

My preliminary report submitted November 30, 1888, described the river and its commerce so fully that but little further discussion is required beyond the mere engineering features of a possible improvement.

In August, 1889, Mr. F. S. Burrowes, United States Assistant Engineer, with the party which had been employed in surveys at other places, completed a survey of the parts of the river in which the obstructions occur. The broad part of the river at its mouth is a part of Union River Bay, and is the only portion of the bay which requires any attention at this time.

For the details of the survey some further points regarding the material deposited in the river and for the plan of improvement which has been matured under my supervision, I refer to Mr. Burrowes's report, which is appended hereto and to the two tracings which are forwarded in a separate roll.

It will be observed that the total expense of the improvement is estimated to be $225,000.

Whether the channel when once dredged in the river will remain in good condition is a matter of grave doubt. It certainly will not so remain while the present custom of depositing mill refuse is continued, and it is probable that even without such continuance the material already there may from time to time become detached and forced into the channel.

As no drift of heavy wood has been formed at the mouth of the river, it is probable that the channel over the bar would be maintained without difficulty.

Very respectfully, your obedient servant,

JARED A. SMITH,
Lieut. Col., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. F. S. BURROWES, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Portland, Me., January 10, 1890.

COLONEL: I have the honor to submit the following report upon a survey of Union River and Union River Bay, Maine, made under your direction in August, 1889, in accordance with river and harbor act of August 11, 1888.

The tidal portion of Union River begins at the city of Ellsworth and runs southerly 4½ miles, where it empties into Union River Bay, which is one of the arms of Blue Hill Bay.

Owing to the lack of funds necessary to make a complete survey of the river two detached surveys were made, one extending from the head of navigation to Lord's wharf, a distance of 1½ miles, and the other, covering the bar at the mouth, a length of 1½ miles, leaving an unsurveyed portion between of 1½ miles. The chart of the U. S. Coast Survey shows depths varying from 7 to 23 feet at mean low water throughout this unsurveyed interval.

The surveys were plotted on two separate sheets, which are herewith submitted. Chart No. 1 shows the river between Ellsworth and Lord's wharf, and is drawn to a scale of 1:2000. Chart No. 2 shows the bar at the mouth of the river, and is drawn to

a scale of 1:3000. A triangulation was made for each survey, the high-water lines and wharves being filled in between by stadia measurement. The soundings were located by intersection with two transits, and depths measured with a lead on a graduated brass chain.

The soundings on both charts are reduced to the plane of mean low water as established by the U. S. Coast Survey in 1879. The bench-mark used is thus described by the Coast Survey. The gauge was fastened to the southeast corner of Captain Bonsey's wharf on the right bank of Union River, 1¼ miles below Ellsworth. The bench-mark is a hole drilled in ledge of rock 20 meters northwest from gauge and 1 meter from high water-mark and filled with lead. It is 40 feet from the northeast corner of Captain Bonsey's house. The bench-mark is 15.55 feet above mean low water. Two auxilliary bench-marks were established, the elevations of which were obtained by water-level at high tide from the Coast Survey bench-mark.

Bench-mark No. 1 is shown on Chart No. 1, and is a horizontal drill hole in ledge 170 feet above Tinker's wharf and is 9 feet above mean lower water.

Bench-mark No. 2 is shown on Chart No. 2, and is a horzontal drill hole in ledge on the point 2,150 feet below the spindle, and is 12.1 feet above mean low water.

The mean range of tides as determined by the Coast Survey at the same time is 10 feet.

From the narrows to Ellsworth there is a crooked channel having a general depth of only a little more than 2 feet at mean low water. In 1871 and 1872 the United States Government dredged a channel in a nearly direct line between the narrows and the old steam-boat landing at Ellsworth. It was made 150 feet wide and 4 to 5 feet deep at mean low water. The present survey indicates that no permanent benefit was derived from the improvement then made. The rapid filling which has taken place is undoubtedly the result of the large quantities of slabs, edgings, shavings, sawdust, and other saw-mill waste which have been and are now thrown into the river. The flats at low-water are seen to be a compact mass of slabs, edgings, butts, sawdust, etc., and at times the surface of the river is so covered with floating débris as to make it difficult to get through it with a small boat. The people living along the banks of the river gather some of the best of the floating wood and pile it above high-water mark to dry for their winter's supply of fuel. In one case I knew of a small sloop coming into the river and loading with wood from the stream. The supply, however, greatly exceeds the demand, and the most of it floats up and down with the tide until it gradually becomes saturated and sinks to the bottom to perform its part in obstructing the channel.

The river at the mouth widens to more than 3,000 feet, and a large bar has formed there which leaves only a narrow channel along the eastern shore with an available depth of a little more than 4 feet at mean low water. This bar, as shown by sixty-one borings made, is composed of sawdust, sand, and mud. The almost entire absence of mill waste, other than sawdust, would seem to indicate that all the larger refuse lodges in the narrow river above.

The commerce of the river, which is quite extensive, consists almost exclusively in carrying out sawed lumber and bringing in coal and some small supplies. The vessels used for this purpose can not have a depth of draught much greater than the flow of the tide, and are towed in and out at extreme high water, one small tow-boat performing the whole service. A small steam-boat, connecting with the Boston and Portland boats, makes tri-weekly trips between points in Blue Hill and Union River bays, and when the tide serves, lands at Lord's wharf, 1¼ miles below Ellsworth. Generally, however, the nearest landing it makes is at Surry, near the head of Patten's Bay.

The following estimate is to obtain a channel by dredging from Lord's Wharf to Ellsworth with a depth of 6 feet at mean low water, and a width through the narrows of 100 feet, and thence a width of 150 feet to and in front of the wharves at Ellsworth. As this channel is at the head of the tidal basin it is thought that if the natural conditions were partially restored and maintained, the depth would hold without the aid of contraction works. In order to obtain a clear depth of 6 feet it will be necessary in material of this nature to make an allowance for dredging at least a foot below grade, and the quantities in the estimate are calculated on that basis for *situ* measurements.

As the river at its mouth has an abnormal width, it is proposed to contract it by a jetty and training-wall running from the western shore across Horton's Rocks and thence parallel to and about 800 feet from the eastern shore. It is to be built of rough stone, with top 6 feet wide and 6 feet above mean low water, and side slopes of 45 degrees. The jetty and training-wall will have a combined length of 6,700 feet and the training-wall will be marked in three places with rough stone beacons built to a height of 6 feet above mean high water.

ESTIMATES.

220,000 cubic yards (in scows) dredging, slabs, edging, etc., at 60 cents	$132,000
67,000 tons of stone for jetty and training-wall, at $1.10	73,700
Contingencies	19,300
Total	225,000

Very respectfully, your obedient servant,

F. S. BURROWES,
Assistant Engineer.

Lieut. Col. JARED A. SMITH,
Corps of Engineers, U. S. A.

A 24.

PRELIMINARY EXAMINATION OF ST. CROIX RIVER, MAINE.

UNITED STATES ENGINEER OFFICE,
Portland, Me., December 28, 1888.

SIR: I have the honor to submit the following report of a preliminary examination of the St. Croix River, Maine, made in compliance with instructions from the Chief of Engineers in letter dated August 28, 1888, and September 29, 1888:

In the autumn of 1886 an examination of the St. Croix River was made and a report was submitted November 22, 1886. In connection with the report now submitted I would refer to the former one, it being quite necessary for a full understanding of the situation. (See Report of Chief of Engineers, 1887, p. 477.)

On the 25th of October, 1888, I visited Calais, and went over essentially the same ground as before. Although it was at a season of the year when it is difficult to get vessels for freights, I saw twenty-nine large sailing vessels, two passenger steamers, one steam-barge, and two tugs lying at the wharves on the American side of the river.

The business of the town of Calais is quite extensive, it being central to a large part of country which has no railroad and no other navigable port. The amount of navigation of the river was so fully set forth in my former report, to which reference has been made, that it does not seem necessary to repeat the figures, which vary but little from year to year. The amount and class of navigation is such as to fully justify an opinion that the river is worthy of improvement.

The difficulties heretofore lying in the way have been that the sawmills were allowing sawdust and other refuse to be thrown into the river where it would again fill the channel. Special pains were therefore taken to ascertain whether any measures were being enforced to prevent further filling of the channel. Several of the mills were visited, and I observed that all the edgings and other waste except sawdust was being hauled away in carts. As the visits were entirely unannounced, there could be no reason for supposing that the carting of refuse was exceptional. One of the principal mill-owners told me that the mills had made contracts for the removal of all the waste except sawdust.

I ascertained that the town authorities of Calais and of St. Stephens had each employed a man as special police to prevent the throwing of waste into the river, and to make complaint for every violation of the law.

The State law is very inadequate for the purpose, for the reasons that

prosecutions are only under a general law, and not one enacted specifically for that purpose. Much of the fine sawdust goes into the river, but the currents are sufficient to remove that material so long as it is not accompanied by bark, slabs, edgings, shavings, etc.

At present the care in this respect seems to be all that can reasonably be required.

I therefore recommend that a survey be made from the bridge to the wide part of the river below Breakwater Ledge, in order that a complete project and estimate of cost may be prepared. In 1877 Colonel Thom submitted an estimate of $150,000 for improving the channel of the St. Croix, and that amount may be assumed as approximately correct now in the absence of any more exact maps.

As the St. Croix River is located on the boundary between Maine and New Brunswick, the channel is one of international interest and jurisdiction.

It therefore seems proper to recommend that the subject should be brought to the attention of the Dominion authorities, in order to secure, if possible, some harmonious joint action in carrying out any improvements which may be found necessary.

A survey of the river as complete as is required, together with observations of the currents and borings or other examinations of the bottom, will cost $1,500.

Very respectfully, your obedient servant,

JARED A. SMITH,
Lieut. Col., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

SURVEY OF ST. CROIX RIVER, MAINE.

UNITED STATES ENGINEER OFFICE,
Portland, Me., December 20, 1889.

GENERAL: I have the honor to submit the following report of a survey of the St. Croix River, Maine, made in compliance with requirements of section 13 of river and harbor act of August 11, 1888, and instructions in letter from Chief of Engineers dated April 1, 1889.

At as early a day as practicable, Mr. F. S. Burrowes, United States assistant engineer, was assigned to the charge of this survey, and the work was completed in the latter part of July. Several other surveys, however, detained the party in the field until the end of September, so that it has been impracticable sooner to complete the various maps and estimates. Mr. Burrowes's report, which is appended hereto, gives a full account of the survey and the information obtained regarding depths of water and the character of obstructions.

The improvement for which the estimate is submitted in Mr. Burrowes's report has been planned after a mutual study of the subject, so that, if an improvement is to be undertaken, the plan submitted is that which has my approval.

In view of the fact that it will be impracticable to remove all the slabs and other mill waste from the river, and that there is more or less liability that parts which remain may become detached and possibly fill the channel previously excavated, I deem it unadvisable that the proposed channel should be made of less dimensions than that for which the estimate of $280,000 is submitted.

This river is one of the numerous streams along which the pernicious practice has obtained of dumping all mill waste into the water until the navigation has been very seriously impaired.

Within two years measures have been taken to prevent all waste except sawdust from being thrown into the river, and this has been partially successful.

No attempt has, however, been made to exclude the sawdust; which has contributed its share to the obstruction, besides tending greatly to destroy the fishing interests.

If the deposit of waste can be restricted to the sawdust, I believe that the annual freshets will be sufficient to keep the channel clear in the upper part of the tidal basin, where ordinary currents are weak.

The question of improving the navigation on the St. Croix River has been so fully discussed in my preliminary report, dated December 28, 1888, and in several former reports included in reports of the Chief of Engineers, that no further explanations are now required.

In a separate package I forward a tracing of a map* made from the recent survey; upon the map the location and extent of improvements here proposed are fully indicated.

Very respectfully, your obedient servant,

JARED A. SMITH,
Lieut. Col., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. F. S. BURROWES, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Portland, Me, December 18, 1889.

COLONEL: I have the honor to submit the following report upon the survey of St. Croix River, Maine, made under your direction in accordance with river and harbor act of August 11, 1888.

The survey was begun June 24 and completed July 23, and extended from the toll-bridge between the cities of Calais and St. Stephen for a distance of 4¾ miles to fender piers built on a dangerous reef of rocks and locally known as the breakwater on "The Ledge." This portion of the river is a part of the northeastern boundary of the United States, between the State of Maine and the province of New Brunswick.

A system of triangles, thirty in number, was made to cover the length of the survey.

The triangulation points were marked wherever possible, either by drill holes in ledge or auger holes in wharves, stakes being used in only four places where more permanent marks were not readily obtainable. A main base line 1,697.50 feet long was measured with a 200-foot steel tape and a check base 608.30 feet in length. The angles in the triangulation were carefully measured and repeated at least twice. The measured and calculated lengths of the check base differed by .04 foot. The high-water line, points of ledge, and wharves were filled in between the triangulation points by stadia measurement. The soundings were located by intersection with two transits, the sounding boat being kept on fixed ranges with one instrument, and the angular distance of each sounding measured with the other. The depths were measured with an 8-pound lead on a graduated brass chain. The bottom was tested in sixty-three places with a steel rod in the end of a graduated wooden pole, the location of each test being determined by intersection with two transits.

The map of the survey herewith submitted is platted on one sheet to a scale of 1:2400. The soundings are referred to the plane of mean low water as determined during the survey of 1873, the tide-gauges being set with zeros in that plane from recorded elevations of bench-marks of that survey. The bench-marks used for the present survey, both old and newly established, are as follows, viz:

Bench-mark No. 1 (old): Top of granite foundation of St. Stephen's bank, 37.42 feet above mean low water.

---

* Omitted.

Bench-mark No. 2 (new): Horizontal drill hole in ledge on line of upper side of lower steam-boat wharf, 16.6 feet above mean low water.

Bench-mark No. 3 (new): Horizontal drill hole in ledge 10 feet below Jewett's Wharf, 18.1 feet above mean low water.

Bench-mark No. 4 (old): Copper bolt in large bowlder on Knight's Point, 24.8 feet above mean low water.

Bench-mark No. 5 (new): Vertical drill hole in ledge 160 feet above pier, at mouth of Bog Brook, 13.6 feet above mean low water.

The survey of 1873 covered the same stretch of river embraced in the present one, and a series of observations made at that time and including 57 consecutive high waters and 57 consecutive low waters developed the following tidal conditions:

	Feet.
Rise of mean high water above mean low water	19.9
Extremes of high water above mean low water	23
	17.6
Extremes of low water:	
Above mean low water	2
Below mean low water	3.4

A comparison of the two surveys shows no considerable change in the condition of the channel except at a point one-fourth mile above "The Ledge" where a shoal with a little less than 15 feet of water on it at mean low water extends three-fourths of the distance across the channel, and which apparently did not exist at the time of the previous survey.

The present condition of the channel is about as follows, the depths being all referred to mean low water:

There is a good channel 12 feet and more deep up to a short distance above Hill's Point, where there is a shoal about 200 feet long having on it only 10½ feet of water, the material of which it is composed being very soft mud and sawdust. Above this shoal the 12-foot channel continues to the point opposite Jewett's wharf with a general width of more than 200 feet and continues further to the old wharf on the Canadian side with a width of about 100 feet. On the crossing from the old Wharf on the Canadian side to the lower steam-boat landing a least depth of 9½ feet and a general depth of 10½ feet is found. From the lower steam-boat wharf to the wharves at Calais and St. Stephen there is a least depth of 6½ feet and a general depth of about 7½ feet, the 9-foot curve occurring in only two or three places. In front of the wharves the depths vary from 1.5 feet to 9 feet, with the exception of a narrow pool on the Canadian side, which is more than 9 feet deep.

The material of which the bottom is composed between Jewett's Wharf and the toll-bridge is mud, sawdust, slabs, and edgings, with some gravel and bowlders immedately below the bridge. The slabs and edgings are less numerous in the channel and increase toward the sides. They also increase in number up-stream until between the wharves the bottom is covered with a compact mass of them.

At the present time it is claimed that sawdust is the only mill waste allowed to escape into the river, and during my stay I did not observe any considerable amount of larger waste in the steam. Large sawdust deposits from 1 to 3 feet thick show in the flats at low water all along the river. As the channel shows no recent shoaling it would seem that the current has been sufficiently strong when not checked by deposits of slabs and edgings to carry the sawdust out to deep water.

I did not obtain any important statistics of the commerce of the river in addition to those fully given in your preliminary reports. During the month of July business on the river was very active, and from three to six or more lumber-laden vessels went out daily.

There is a daily steam-boat line from Calais to Eastport, connecting at that place with the International line of steamers between Boston and St. John. This boat runs approximately on time, and when the tide serves it lands at the wharf immediately below the toll-bridge. Generally, however, it is compelled to land at the lower wharf, which is inconveniently located 1½ miles down the river.

The project for improvment upon which the following estimate is based is to obtain a channel 12 feet deep at mean low water, generally 200 feet wide and narrowed to 150 and 100 feet in the upper part of the harbor to avoid ledge. This would yield a depth of nearly 9 feet at extreme low water, and would enable the steam-boat to land at the upper wharf at all stages of tide. It would also allow the larger lumber vessels to fully load at the wharves instead of, as now, being compelled to drop down to the deep water below "The Ledge" after being only partially loaded, and finish out by the expensive method of rafting the lumber to that point and hoisting it on board from the water.

It is proposed to obtain this channel above Jewett's Wharf by dredging. Such a channel, when once obtained here, would doubtless maintain itself if care is taken to *keep mill waste out of the river.*

The conditions at the shoal above Hill's Point are, however, different. The material is very soft and the river wide and if dredging was resorted to to secure the desired depth it is probable the same shoaling would soon again take place if the regimen of the river remains unchanged. For this purpose a small jetty and training-wall having a total length of 600 feet is proposed to jut out from the right bank of the river near the lower end of the shoal to deflect the flood current to the eastward and produce a scouring action over the shoal. This structure is to be rough stone built to a height of 8 feet above mean low water, with a width on top of 6 feet and side slopes of 45 degrees. The desired result could be more economically and satisfactorily obtained by building the jetty out from the Canadian shore near the head of the shoal, if the permission of the Dominion government could be obtained for such location.

If it should be thought sufficient to obtain a depth of only 9 feet at mean low water above the lower steam-boat wharf, the estimate would be reduced by 180,000 cubic yards (*in situ*) of dredging.

Estimate.

420,000 cubic yards (*in situ*) dredging mud, sawdust, slabs, and edgings, at 60 cents	$252,000
5,500 tons of stone for jetty, at $1	5,500
Engineering and contingencies	22,500
Total	280,000

Very respectfully, your obedient servant,

F. S. BURROWES,
Assistant Engineer.

Lieut. Col. J. A. SMITH,
Corps of Engineers, U. S. A.

A 25.

PRELIMINARY EXAMINATION OF PLEASANT RIVER, FROM COLUMBIA FALLS TO ITS MOUTH, MAINE.

UNITED STATES ENGINEER OFFICE,
Portland, Me., December 29, 1888.

SIR: In compliance with instructions from the Chief of Engineers, in letters of August 28 and September 29, I have the honor to submit the following report of a preliminary examination of Pleasant River, Maine, from Columbia Falls to its mouth.

On the 1st of November, 1888, I visited Columbia Falls, at the head of navigation on the Pleasant River, and afterwards visited other points on the river below.

The river has its rise in the interior of the southeastern quarter of the State, and is about midway between the Penobscot River and the boundary between Maine and New Brunswick.

The head of tide-water and of navigation at Columbia Falls is in a direct line about 12 miles north of the headlands of the coast and about 20 miles north of the island headland.

The river is central to more than 250 square miles of territory, including several towns and villages, as a shipping and receiving point for freights.

While the freights include considerable lumber, pulp wood, spool wood, canned fruits, agricultural products, etc., yet they can not properly be described as very extensive.

So far as I could ascertain by inquiry, observation, and comparison of various accounts, the amount of business by navigation may be approximately summarized as follows:

At Columbia Falls there are two lumber mills, which together ship annually an average of 3,000,000 feet of long lumber, besides the small stuff which is cut into laths, pickets, shingles, etc.

A canning factory shipped 13,000 cases of berries in the summer of 1888.

At Columbia, a short distance above, are two heading mills, the products of which are shipped from Columbia Falls.

The vessels carrying these freights are frequently loaded upon the return trips, and they bring the principal supplies for a large area of surrounding country. There is no railroad in that part of the State, and no steam-boat line touching nearer than Millbridge, 15 miles southeast, or at Jonesport, 13 miles southwest.

The vessels going up as far as Columbia Falls draw from 6 to 9 feet of water, and carry from 50,000 to 90,000 feet of lumber in one freight. The number may be given approximately as follows:

	Vessels.
Lumber shipments	50
Spool wood, shipments	1
Pulp wood, shipments	5
Fruit, potatoes, etc., shipments	5

One schooner of about 100 tons register has been built at Columbia Falls the past season, and another is reported as soon to be built.

The river from Columbia Falls to Addison Point is said to be 5 miles or more, although the direct line does not exceed 3 miles.

At Addison's Point the river becomes broad, and below that place it is more like a long, narrow bay, and unless the mouth of the river be at Addison Point, it is difficult to say at what exact point it should be located.

Some maps which have been issued give the name of the river as far down as a narrow part of the bay about 5 miles below Addison Point. A small settlement near the narrows mentioned is called Pleasant River. I therefore assume that the mouth of the river is at the narrowest place in the bay, near the Pleasant River settlement.

On the river, between Columbia Falls and Addison Point, is a formation of clay, which is reported to be of excellent quality for the manufacture of terra cotta for building purposes, and also for fire-bricks. A company has been formed, with a capital of $75,000, to enter upon the manufacture of bricks and terra cotta. Should the enterprise prove a success it will make a very important addition to the amount of freights and to the necessity for improvement.

At Addison Point the best information I could obtain indicated the arrival annually of seventy-five vessels of from 60 tons to 200 or more tons registered.

Five vessels of from 65 tons to 100 tons registered capacity are employed regularly between Addison Point and Boston. The vessels carry freight in both directions, the outward freights consisting mainly of granite.

There is a granite quarry near Addison Point and another at Pleasant River, from both of which a fine quality of stone is shipped.

No accurate map of the river or bay has yet been published, so that the depths and condition of the river could only be ascertained in a general way. Inquiries were made of a large number of business men, sailing masters, and pilots.

The river from Columbia Falls to Addison Point is such that at ordinary high water a vessel drawing 9 feet can be taken through if *handled with care*. The rise of the tide is about 12 feet at Addison

Point, but at low water the river has so much declivity that the tide raises the water at Columbia Falls only about 8 feet.

The obstructions between Columbia Falls and Addison Point are said to be of rocks, either bowlders or ledge, and probably also mill refuse. The mills are at present putting refuse into the water, and it can hardly have failed to cause more or less obstruction.

Below Addison Point there are shoals, bowlders, and rocks, some of which were marked by buoys last spring, placed under direction of the Light-House Board. These obstructions are such that a vessel drawing 7 feet of water can not safely pass over at a lower stage than half-tide, and vessels of 12 feet or more draught must wait until near high water.

While some delays are thus caused I believe that the difficulty would be made much less, and perhaps sufficiently removed, by more complete marking with buoys, and the expense would be far less than to attempt the removal of the rocks.

The freights which are taken out of Pleasant River enter into the general business and commerce of the country, and to that same extent the improvement of the transportation route is of general interest.

There seems to be but little doubt that some small improvements to the navigation would result in further developing the granite works, and it would also add to the opportunity for manufacture of bricks and terra cotta.

I have no means of making even an approximate estimate of the cost of such improvements as may be necessary, and it is possible that after a survey has been made it may be found unadvisable to attempt the improvement owing to the material or the cost of the work.

If the obstructions are found to be mainly of mill refuse they should not be removed unless arrangements are made to rigidly exclude such deposits from the river in future.

It also follows, as a matter of course, that improvements should not be undertaken unless they promise a degree of permanence at a cost which shall not be disproportionate to the benefits.

It is my opinion that the river is worthy of improvement.

I recommend that a survey of the river be made from Columbia Falls to Addison Point; also examinations or detached surveys of the obstructions in the river below Addison Point.

The expense of the survey recommended is estimated at $1,200.

Very respectfully, your obedient servant,

JARED A. SMITH,
Lieut. Col., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

SURVEY OF PLEASANT RIVER FROM COLUMBIA FALLS TO ITS MOUTH, MAINE.

UNITED STATES ENGINEER OFFICE,
Portland, Me., February 5, 1890.

GENERAL: I have the honor to submit the following report of a survey of the Pleasant River, Maine, from Columbia Falls to its mouth, accompanied by two tracings* from the maps of the portions surveyed.

*Omitted.

My preliminary report, dated December 29, 1888, discussed the subject so fully that but little remains, save to report results and estimates.

The funds which could be allotted to the survey were entirely inadequate to make it complete in details, and I was therefore compelled to limit the work to a careful reconnaissance of the part above the bridge, and to a small detached survey of reefs near the channel below.

The map of the upper part of the river is shown upon chart No. 1 and that of the reefs upon chart No. 2.

The report of Mr. F. S. Burrowes, assistant engineer, appended hereto, sufficiently explains the situation.

The estimate of $3,500 is, I believe, ample to cover all work at present necessary. It will be observed that only part of the amount estimated is for the improvement of the channel, the other part being for the construction of beacons to mark rocks near the channel.

The channel below Addison Point is ample for all present or prospective demands; but the rocks known as Channel Rocks and Coffin's Rocks should be distinctly marked by beacons. At high water these rocks are covered, and form dangerous obstructions. Three good beacons, or even spindles, would be of great service in marking the position of the rocks.

It may be added, that should the beacons be erected under direction of the Light-House Board, as is usual in such cases, the amount required for improving the river by removing bowlders above Addison Point will be but $1,200.

Very respectfully, your obedient servant,

JARED A. SMITH,
Lieut. Col., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. F. S. BURROWES, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Portland, Me., February 4, 1890.

COLONEL: I have the honor to submit the following report of the survey of Pleasant River, Maine, made under your direction in August, 1889, in accordance with river and harbor act of August 11, 1888:

Owing to a lack of funds, the time which could be given to the field-work was limited to two weeks, and the effective working time was further shortened by fog and rain. As the river has a total length of about 12 miles, and a general width below Addison Point of about a half mile, it was evident that a survey of the whole river could not be made in this time. Attention was therefore confined to the parts of the river especially mentioned in your preliminary report; that is, the narrow river between Columbia Falls and Addison Point and the rocks in the channel in the vicinity of Reef Point.

The survey was plotted on two charts which are submitted herewith. Chart No. 1 shows the river between Columbia Falls and Addison Point (a distance of 5¼ miles) on a scale of 1:3000. Chart No. 2 shows location of rocks in the vicinity of Reef Point, and is drawn on a scale of 1:2000.

The soundings on both charts are reduced to the plane of the mean of the low waters observed during the survey. The mean range of tides at Addison Point, as given by the Coast Survey, is 11.3 feet.

The survey between Columbia Falls and Addison Point can only be regarded as a close reconnaissance, the distances having been measured with the stadia. At Reef Point a base line was measured and a triangulation carefully made. In both cases the soundings were located by intersection and the depth measured with a graduated brass chain. In the river above Addison Point where it was at times found necessary to make soundings a mile or more from the tide-gauge, care was taken to make such soundings at or near high-water slack, so as to eliminate as far as possible the errors due to surface declivity.

The width of the river between Addison Point and Columbia Falls varies from 400 feet to 200 feet, and the depth at low water shoals quite gradually up-stream from 8 feet to 0 feet. The present method of navigating this portion of the river is for vessels drawing 9 or 10 feet of water to start from Columbia Falls at high water and slowly kedge or float with the tide down-stream, the channel being too narrow to permit the effective use of sails, and the traffic not sufficiently great to justify the employment of a tow-boat. It usually takes two tides to make the trip from Columbia Falls to Addison Point where the river widens so that sails can be used.

At several points in this part of the river large bowlders have gradually worked into the channel and have caused some damage and delay to vessels drifting upon them. Their removal would be of benefit to the navigation of the river. Any other scheme of improvement would require the dredging of the channel of the river and the basin at Columbia Falls to a depth of at least 6 feet at low water. The cost of such improvement would be large, and a correct estimate could not be made without a closer survey and an examination of the character of the bottom by means of borings. At Addison Point the river is crossed by a bridge with a draw-span of an antiquated type, which gives a clear opening of 35.8 feet. The bridge is owned and operated by the town of Addison.

Below Addison Point, according the Coast Survey chart and the testimony of those using the river, there is a good depth of water, and the channel is free from serious obstructions except in the vicinity of Reef Point. The principal obstructions here are two rocks in mid-river projecting only slightly above low water. The channel between them is deep, but is only 90 feet in width. Above these rocks is a shoal of broken ledge, bowlders, and gravel (known as Coffin's Rocks), and further above a rock projecting nearly to high water and known as Bungee Rock. The line of deepest water is between the channel rocks, thence to the westward of Coffin's Rocks, and thence to the eastward of Bungee Rock. This channel is, however, narrow and crooked, and hard to navigate in a sailing vessel. The usual course, therefore, is to the eastward of all the obstructions, where there is water enough for vessels of the draught used to pass over at half-tide. The obstructions are principally hazardous, because being in a wide part of the river they are difficult to locate at high water. If the channel rocks were marked by stone beacons or iron spindles on one or both of them, and the location of Coffin's Rocks well designated by bouys, the present traffic of the river could be carried on without serious hazard or delay.

The details of the traffic of the river, as fully given in your preliminary report, correspond substantially with the information I was able to obtain while making the survey. A yard and mill for making bricks by machinery was established during the past summer on the river 1½ miles below Columbia Falls. Two small schooners were being built in the yards at Columbia Falls. It is estimated that the bowlders could be removed from the river between Addison Point and Columbia Falls for $1,000, and that stone beacons could be placed on the channel rocks for $2,000, which with an addition for contingent expenses would make a total estimated cost of improvement of $3,500.

Very respectfully, your obedient servant,

F. S. BURROWES,
Assistant Engineer.

Lieut. Col. JARED A. SMITH,
Corps of Engineers, U. S. A.

A 26.

PRELIMINARY EXAMINATION OF KENNEBUNK RIVER, MAINE.

UNITED STATES ENGINEER OFFICE,
Portland, Me., January 7, 1889.

SIR: I have the honor to submit the following report of a preliminary examination of the Kennebunk River, Maine.

In compliance with instructions from the Chief of Engineers, I visited the Kennebunk River, December 1, 1888.

The navigable portion of the river is practically limited to the part from its mouth to the bridge, a distance of less than 1¼ miles; the bridge, however, is provided with a draw and small vessels occasionally go to points above.

The river is in the collection district of Kennebunk, of which Kennebunk is the port of entry.

From above the bridge to the mouth of the river on the east side is situated the village of Kennebunkport, which is a port of delivery.

Improvements were commenced upon the Kennebunk River in 1798 by the State of Massachusetts, under sanction of Congress, which authorized a duty for re-imbursing the expense.

From March 2, 1829, to March 3, 1881, inclusive, Congress made appropriations amounting to $65,175 for improving the Kennebunk River.

Two jetties were constructed across the bar at the mouth of the river.

The east jetty is about 545 feet long and has a substantial pier-head at the outer end to serve as a base for a beacon.

On the shore end the jetty has a wing extending obliquely inland a distance of 225 feet.

The west jetty is of essentially the same type, though smaller; its length is 290 feet, and the wing extends 160 feet obliquely from the jetty. Both jetties are built of heavy stone carefully laid up in steps without mortar. These piers have both been much injured by the action of the sea in heavy gales, assisted no doubt by the effects of changing temperature and by the ice.

The first jetty on the east side was of wooden cribs filled with stone, and the present stone jetty utilizes the old work in part for a foundation. The old wood-work extended several hundred feet above the mouth of the river for a shore protection, and a pier about 300 feet long, like a wharf, was built for a similar purpose about 1,000 feet above the mouth of the river.

The title to the land immediately bordering the shore on the east side, covering the place where the works named were built, is vested in the United States, though the descriptions and marks for the boundaries do not seem to be entirely explicit.

The present commerce of the Kennebunk River is very small. The latest statistics received are for the year ending June 30, 1888, viz:

Arrivals and departures of vessels coastwise	75
Vessels built in the district	3
Tonnage of vessels built	75

The improvements already made seem to me to be as great as the business and commerce of the place justify.

It does not however appear to be good policy to permit the works already built to become ruined from lack of care and repairs. The channel proper of the river does not appear at present to require any attention.

It would seem that such repairs or reconstruction of works already built as may be needed to maintain them in good condition should be carried out, but the amount of navigation does not justify anything further.

With special reference to the preceding remarks I consider the river worthy of improvement.

It will be impracticable to give an estimate of expense of repairs until a small survey can be made to obtain dimensions and details of the old works for which the office has no drawings. Such a survey will cost $100.

Very respectfully, your obedient servant,

JARED A. SMITH,
Lieut. Col., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

SURVEY OF KENNEBUNK RIVER, MAINE.

UNITED STATES ENGINEER OFFICE,
Portland, Me., January 11, 1890.

GENERAL: In compliance with the requirements of section 13 of river and harbor act of August 11, 1888, communicated with instructions from Chief of Engineers dated April 1, 1889, I have the honor to submit the following report of a survey of the Kennebunk River, Maine.

A preliminary report was submitted January 7, 1889, in which the river and its commerce were described. Later in the season it was reported to me that the east jetty had been considerably injured in heavy storms.

In June, 1889, I made a careful examination of the west pier, and subsequently employed Mr. William B. Bennett to make a survey of all the piers and the Government land.

The maps of the river from surveys made in 1877 and 1878 being sufficient for all present purposes, no further survey of the channel has been made.

During a period extending from 1829 to 1881 fourteen appropriations, aggregating $65,175, were made for the improvement of the Kennebunk River. (See Report of Chief of Engineers, 1888, page 392.)

Under these appropriations the jetties of stone, the wooden pier, and other works mentioned in my preliminary report were constructed.

In addition to these works the channel was widened in several places and deepened in two places by dredging to a depth of 4 feet at mean low water, and the tops of some ledges of rock were removed to the same depth.

The range of tides in the Kennebunk River is 9 feet between the planes of mean low and mean high water.

The dredging which was done does not appear to have resulted in any permanent benefits, as the channel has filled so much that coal-vessels of more than 10½ feet draught of water can not be sure of an entrance at high water on the low range of tides. This makes it somewhat difficult to procure suitable vessels and doubtless increases the cost of freight.

The principal point where the filling has occurred is at the "Wading Place," which was formerly deepened.

To accompany and explain this report I forward in a separate roll two tracings in sheets numbered 1 and 2. The map upon sheet No. 2 gives the soundings which were taken after the dredgings were completed and they do not represent the present condition.

To preserve the channel at the "Wading Place" it will be necessary to construct a jetty and training-wall which shall contract the sectional area of the river and force the currents through the part where the depth is required. There seems to be but little doubt that with this improvement a depth of 5 feet or more at low water may be maintained over the shoal, and this would permit the loading of vessels at least 2 feet deeper than the present limited draught.

The old wooden pier just below the "Wading Place" is very insecure. Its original design was to prevent vessels from being drifted upon the rocky shore where the channel changes direction. The pier consists of a crib-work of timber floored over at a considerable height above the bottom and held down by a weight of gravel and clay.

Kennebunkport being a summer resort, this pier is much frequented by visitors, especially women and children. Some five or six years ago

a portion of the flooring and its load fell in, and that part was subsequently repaired. In a place like this it is quite impracticable to prevent the gathering of visitors upon the pier, and it should therefore be made secure.

The location of the pier is indicated upon the map of mouth of river. Both the east and the west jetties at the mouth of the river need extensive repairs.

The plan and general features of sections and elevations of the two jetties are indicated upon sheet 1 of the tracings. The details given also indicate clearly the general condition of the works and the injuries which have been received.

The east jetty not only requires to be substantially relaid where the break has occurred, but repairs are required to foundations in various places.

It is apparent that the heavy seas running upon shore in the angle formed by the two parts of east jetty (see map on sheet 2) hold much of the sand in suspension, and so wash it through the open spaces to the channel on the other side.

To remedy this trouble, as well as to give greater stability to the work, the outer stones where the sand is so washed may be laid in a mortar of hydraulic cement.

The repairs required to the west jetty are few and simple, consisting merely in relaying a portion of the wall and possibly adding a few stones where settling has been discovered.

As remarked in my preliminary report, the commerce of the Kennebunk River is not large. Kennebunk is, however, a port of entry.

The present annual consumption of coal at Kennebunkport is 7,000 tons, and the annual increase is said to be about 10 per cent.

About 250,000 feet, board measure, of lumber is also brought in by water.

I recommend that the work be not undertaken until funds at least sufficient to complete the repairs can be made available in a single sum.

The estimated cost of the improvement and repairs described is as follows, viz:

Jetty and training-wall, 5,500 tons stone, at $1.25		$6,875
Repairing wooden pier by filling with stone:		
Outer walls, 2,000 tons split stone, at $2	$4,000	
Filling, 2,000 tons rubble-stone, at $1.25	2,500	
		6,500
Repairing east jetty, removing and relaying 2,000 cubic yards of stone (part in mortar), at $2.50		5,000
Repairing west jetty, removing and relaying 200 cubic yards of stone, at $2.50		500
Contingencies of engineering, etc		1,125
Total		20,000

Very respectfully, your obedient servant,

JARED A. SMITH,
Lieut. Col. Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

A 27.

PRELIMINARY EXAMINATION OF COCHECO RIVER, NEW HAMPSHIRE, FROM DOVER TO ITS MOUTH.

UNITED STATES ENGINEER OFFICE,
Portland, Me., January 3, 1889.

SIR: I have the honor to submit the following report of a preliminary examination of the Cocheco River, New Hampshire, made on the 20th of November, 1888, in compliance with instructions from the Chief of Engineers, in letters dated August 28, 1888, and September 29, 1888.

The Cocheco River unites with the Salmon Falls River about 3 miles below Dover, N. H., and thus forms the Piscataqua River, which flows along the southern part of boundary between Maine and New Hampshire. The mean range of tides on the river at Dover is about 6¾ feet. Though under a different name, the river really forms a part of the Piscataqua, the head of navigation being at Dover, about 13 miles above Portsmouth, and nearly 17 miles from the open water of the Atlantic Ocean.

The importance of improving the Cocheco River has heretofore been set forth in various reports, and has been recognized by Congress, which has made several small appropriations for improving the channel.

A channel, 50 feet wide and 5 feet deep at mean low water, has been cleared through the obstructions, which were all within 1½ miles of Dover.

The increase of business and navigation has fully kept pace with the improvements.

During the past season ninety-seven vessels came to Dover loaded with coal; the average weight was about 300 tons, but on the day I visited the river one large schooner had come to the wharves in an unusually high tide with 600 tons of coal on board. Generally it is necessary to bring coal in small vessels, or to lighter it at a distance of 1½ miles; in either case the extra expense is approximately 35 cents per ton, as the extra cost of freight in small vessels is about equal to the cost of lightering the larger ones.

In addition to the coal, thirty-four vessels of about the same average capacity arrived at Dover with cargoes of iron pipe, paving stones, ashes, fish, lumber, laths, shingles, cement, and superphosphates.

Dover has extensive manufactures. These consist of cotton and woolen fabrics, prints, leather belting, cement pipe, and bricks. There are also tanneries, glue works, machine works, and foundry (two establishments), knife factory, and box manufactory.

These interests are all quite large and are all directly or indirectly interested in having a depth of water in the river which will enable large vessels to reach Dover without lightering. To accomplish this a depth of 8 feet at mean low water should be obtained and the improved channel should be increased in width to 75 feet, if found practicable.

There are so many indirect results produced from reducing the rates of freights by water, which of necessity brings a reduction of freight rates on many articles brought by rail, that it is difficult to estimate the benefits to a city and the surrounding country of which it is a commercial center.

With a deeper channel many additional articles, such as cotton, leather, iron, cement, lime, fertilizers, etc., would be brought by water at rates cheaper than they have heretofore been received by rail.

These points fully indicate that the river is worthy of improvement. A further survey of the river will be required, for which the estimated cost is $600.

Very respectfully, your obedient servant,

JARED A. SMITH,
Lieut. Col., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

SURVEY OF COCHECO RIVER, NEW HAMPSHIRE, FROM DOVER TO ITS MOUTH.

UNITED STATES ENGINEER OFFICE,
Portland, Me., December 14, 1889.

GENERAL: I have the honor to submit the following report upon a survey of the Cocheco River, New Hampshire, and an estimate of the cost of improvement, as required in section 3 of act of Congress of August 11, 1888:

My preliminary report submitted January 3, 1889, gave a general statement of the condition of the river and its commercial necessities.

The report was, however, inaccurate in stating that the channel hitherto obtained was 50 feet wide. The channel through the narrowest places, where it is limited by the hard rock, has a width of but 40 feet. Such a narrow width of channel is barely sufficient to permit the passage of ordinary vessels of good size for freighting coal, bricks, etc., when using the utmost care.

Many of the vessels which are now being profitably used in a traffic like that of the Cocheco River, have a width often as great as 40 feet, and when loaded they have draughts of water as great as 18 feet or more. Up to the extreme limit of the draught of vessels, the most convenient vessel for use is that of such capacity that it utilizes all the depth which the channel safely affords.

As the tides affect the Cocheco River, the depth at or near high water is that which determines the extreme draught into which a vessel may be loaded.

The points then to consider in determining the low-water depth of channel which should be made, are: First, the range of tides; second, the depth of water intervening between the proposed improvement and the sea, and third, the draught of suitable vessels for the commercial necessities.

The mean range of tides is a little more than 6½ feet. The level of high water for about half of each month is less than the mean range above low water, so that the depth of full tide upon which a vessel could safely count when loading for this destination, would not exceed 6 feet.

Above the entrance to Great Bay the Piscataqua River has a low-water depth generally exceeding 8 feet, but there are places where the present reliable depths do not exceed 7½ feet. It would, therefore, be of little practical value to make the depth at low water in the Cocheco River greater than 7½ feet, as it flows into the Piscataqua at a point above the shoals mentioned.

An improvement of suitable width which will give at least 7 feet in depth in the channel will permit vessels drawing 13 feet to pass in

safety, and I consider such a draught small enough for the average vessels which will be needed.

In places where the bottom is of rock, the depth should be at least 6 inches greater than elsewhere, because vessels are frequently loaded so that their keels will drag on the soft bottom.

An improvement suitable for the purpose therefore seems to be to obtain a channel depth of 7 feet, which shall be increased to 7½ feet when passing over rock. The channel should have a minimum width of at least 50 feet when confined in rock where a greater width would be too expensive, and the width should increase to 60 and 75 feet as the material becomes less expensive to remove.

The entire improvement so planned is estimated to cost $175,000.

A complete survey of the Cocheco River was made under my direction in September, 1889, by Mr. F. S. Burrowes, assistant engineer.

The report of Mr. Burrowes, appended hereto, to which I respectfully refer, describes the survey and discusses the improvement and estimate.

A tracing* from the map of the survey, showing the proposed improvements, is forwarded by mail in a separate package to accompany this report.

Very respectfully, your obedient servant,

JARED A. SMITH,
Lieut. Col., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. F. S. BURROWES, ASSISTANT ENGINEER.

PORTLAND, ME., *November* 25, 1889.

COLONEL: I have the honor to submit the following report upon a survey of the Cocheco River, New Hampshire, made during the month of September, 1889:

The portion of the river surveyed extends from the head of navigation in the city of Dover to the mouth, where its confluence with the Salmon Falls River forms the Piscataqua River, a total distance of 3 miles. Several surveys have been previously made of the part of the river between Dover and the lower narrows, a distance of 1¼ miles, and for purposes of comparison the present survey was well connected with them by means of the old triangulation points marked by drill-holes in the ledge.

A triangulation containing fifty triangles was made to cover the entire length of the survey, such a large number of triangles being necessary in order to obtain them of fairly symmetrical shape, as the banks are generally steep and high, and the channel in several places crooked and narrow. Five base lines were measured with a steel tape, one at the upper end 346.05 feet long, one at the lower end 590.45 feet long, and three intermediate. Whenever possible the triangulation points were marked by drill-holes in ledge or large bowlders, twenty-eight of them being so marked. The high-water line and adjacent topography was filled in between triangulation points with the telemeter.

The soundings were located by keeping the boat on a fixed range with one transit and taking the intersection angle for each sounding with another transit. The depths were measured either with a graduated rod or with an 8-pound lead on a graduated brass chain.

The tide-gauges were set with zeros at mean low water from recorded elevations of bench-marks of the previous surveys. The difference in level between mean high water and mean low water from observations taken during the former surveys is given as 6.8 feet.

For comparison and estimates the survey was platted in the field on seven sheets, five to a scale of 1:500 and two to a scale of 1:1 000. The final map, which is submitted herewith, is made on one sheet to a scale of 1:2000. The soundings are expressed in feet and tenths, and are referred to the plane of mean low water, those marked

---

*Omitted.

"minus" indicating elevations above that plane. The 0, 2, 4, 5, 6, 7, and 8 feet curves of equal depth are shown by lines of different colors.

The bench-marks used, both old and newly established, are indicated on the map, and are as follows:

Bench-mark No. 1 (old). Top of iron bolt in ledge in upper narrows, south side, is 7 feet above mean low water.

Bench-mark No. 2 (old). Top of iron bolt in ledge on Clement's Point is 6.5 feet above mean low water.

Bench-mark No. 3 (new). Drill-hole in ledge 100 feet above the mouth of Trickey's Brook is 6.7 feet above mean low water.

Bench-mark No. 4 (old). Horizontal step cut in large bowlder, lower narrows, north side, is 9.89 feet above mean low water.

Bench-mark No. 5 (new). Drill-hole in ledge opposite Gardiner's Point is 5.2 feet above mean low water.

Bench-mark No. 6 (old). Top of iron bolt in ledge in Pinkham's Point is 7.8 feet above mean low water.

Tests of the bottom were made in more than three hundred places with a half-inch steel rod 5 feet long in the end of a graduated wooden pole, the position of each test being located by intersection with two transits.

The material above a plane 7 feet below mean low water was thus found to be about as follows:

In the harbor of Dover there is soft sand, mud, and logs, with two small areas of a hard mixture of gravel and clay, and classified as hardpan.

From Collins's Wharf through the upper narrows to Clement's Wharf the bottom is solid ledge, with the exception of one small pocket of sand, mud, and gravel.

From Clement's Wharf to Trickey's Brook the material is composed of hardpan, very large bowlders, sand, and gravel, with a small point of ledge projecting into the channel from Clement's Point.

Between Trickey's Brook and Alley's Point the material is mostly sand and mud, with some clay and small bowlders.

Through Alley's Point cut there is clay and bowlders.

The bottom through the lower narrows is all ledge.

Below the lower narrows the material is almost entirely soft sand and mud, with clay in a few places.

PREVIOUS IMPROVEMENT.

Under several projects the river between Dover and the lower narrows has been improved so as to give a depth of 5 feet at mean low water, with a general channel-width of 60 feet and a least width of 40 feet. This depth still obtains, except in two places, where there are shoals 4 or 5 inches above grade. The channel-width has been slightly contracted in several places by gradual washing in of material from the sides. To obtain this depth no work was necessary below the lower narrows, as that part of the river has a good channel more than 6 feet deep.

PROPOSED IMPROVEMENTS.

The plan of improvement estimated upon and indicated on the map, after a consultation with yourself, is to obtain a channel having a general width of 75 feet; a width through hardpan and bowlders of 60 feet, and a least width through ledge in narrows of 50 feet; with a least depth of 7 feet at mean low water, and on ledge of 7½ feet. The extra half foot of depth is made over the ledge, as vessels are now brought up the river laden so as to drag on the bottom, as presumably will be the case after the completion of this project, and while this can be done with safety over sand or clay, it would be attended with danger over ledge.

The general depth of 7 feet was determined upon partially with reference to the condition of the Piscataqua River below the mouth of the Cocheco, where there are said to be several shoals with a little less than 8 feet of water over them at mean low tide.

Above the lower narrows the river is generally narrow, and the character of the material such that the proposed channel, when once obtained, will maintain itself. Below the narrows, however, as the river widens and the material is mostly sand and mud, a few contraction works are regarded as necessary for the maintenance of the desired channel. For this purpose five jetties, with training walls, are proposed. They are to be of rough stone, upon foundations of brush fascines, the tops to be 6 feet wide, and to be in a plane midway between mean high and mean low-water levels. They are shown on the map and lettered A, B, C, D, and E.

ESTIMATE.

6,600 cubic yards (in situ) ledge excavation, at $10.50 per cubic yard	$69,300
20,100 cubic yards (in scows) dredging hardpan and bowlders, at $2.50 per cubic yard	50,250
50,000 cubic yards (in scows) dredging sand, mud, and clay, at 45 cents per cubic yard	22,500
12,000 tons stone for jetties, at $1.25 per ton	15,000
3,600 brush fascines at $1	3,600
Contingencies and engineering (about 9 per cent.)	14,350
Total	175,000

Very respectfully, your obedient servant,

F. S. BURROWES,
Assistant Engineer.

Lieut. Col. JARED A. SMITH,
Corps of Engineers, U. S. A.

APPENDIX B.

IMPROVEMENT OF RIVERS AND HARBORS IN MASSACHUSETTS.

REPORT OF LIEUTENANT-COLONEL S. M. MANSFIELD, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1890, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Newburyport Harbor, Massachusetts.
2. Merrimac River, Massachusetts.
3. Powow River, Massachusetts.
4. Ipswich River, Massachusetts.
5. Harbor of Refuge, Sandy Bay, Cape Ann, Massachusetts.
6. Gloucester Harbor, Massachusetts.
7. Manchester Harbor, Massachusetts.
8. Lynn Harbor, Massachusetts.
9. Winthrop Harbor, Massachusetts.
10. Boston Harbor, Massachusetts.
11. Hingham Harbor, Massachusetts.
12. Scituate Harbor, Massachusetts.
13. Plymouth Harbor, Massachusetts.
14. Wellfleet Harbor, Massachusetts.
15. Provincetown Harbor, Massachusetts.
16. Removal of sunken vessels or craft obstructing or endangering navigation.

EXAMINATIONS AND SURVEYS.

17. Crane and Waters rivers of Essex Branch, Massachusetts.
18. Weymouth (Fore) River, Massachusetts.
19. Beverly Harbor, Massachusetts.
20. Salem Harbor, including South River, Massachusetts.

HARBOR LINES.

21. Establishment of harbor lines at Boston Harbor, Massachusetts.

UNITED STATES ENGINEER OFFICE,
Boston, Mass., July 8, 1890.

GENERAL: I have the honor to transmit herewith annual reports for the works of river and harbor improvement in my charge for the fiscal year ending June 30, 1890.

Very respectfully, your obedient servant,

S. M. MANSFIELD,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

B 1.

IMPROVEMENT OF HARBOR AT NEWBURYPORT, MASSACHUSETTS.

Newburyport is situated on the south bank, 2½ miles, approximately, from the mouth of the Merrimac River. The river empties into the Atlantic Ocean, midway between Cape Ann and Portsmouth, or about 30 miles a little east of north from Boston in a direct line.

The outlet of the river between Plum Island and Salisbury Point is 1,000 feet wide and 30 feet deep at mean low water. At a distance of nearly a mile outside lies a sandy bar, thrown up by wave action, through which, previous to the improvement, a channel variable in position, direction, and depth was maintained by the current of the river, increased by the tidal prism in a large interior basin due to a range of tides equaling 7½ feet.

For 1,000 feet outward from the gorge towards the crest of the bar the current was able to maintain a channel of navigable width and 18 feet deep at mean low water, and for a further distance of 1,500 feet a channel 12 feet deep. From the 18-foot contour on the inside to the same on the outside the distance was 4,000 feet, and between the 12-foot contours the distance was 3,000 feet.

The depth on the crest of the bar was generally less than 7 feet at mean low water.

The object of the improvement is to create through the outer bar a channel 1,000 feet wide and at least 17 feet deep at mean low water, so that vessels may cross the bar and find a harbor, at any stage of the tide, with as great draught as can reach Newburyport by the river at high tide.

The project submitted September 16, 1880, proposed two converging rubble-stone jetties, their outer ends parallel for 1,000 feet, and about the same distance apart, and the protection of the beach in their vicinity. This was modified in 1882 so as to provide for the partial closing of Plum Island Basin with a timber dike about 800 feet long and 5½ feet above mean low water.

The direction of the south jetty and the character of the shore protection was modified in 1883. The north jetty from Salisbury Beach is to be 4,000 feet long, approximately, and the south jetty from Plumb Island is to be 2,400 feet long, approximately.

Both are 15 feet wide on top, which is in a plane 12 feet above mean low water. The two jetties have slopes of 1 on 2 on the sea-side, and of 1 on 1 on the harbor-side.

A map showing the location of the jetties is published in the Annual Report of the Chief of Engineers for 1885.

Their form and dimensions are shown in the Report for 1881. The location and details of construction of the dike are given in the Report for 1883. The estimated cost of the improvement was $375,000.

The total appropriations for this work to date have been $232,500.

The amount expended to June 30, 1889, was $211,444.95, exclusive of outstanding liabilities.

On June 30, 1889, the condition of the improvement was as follows:

The north jetty had been completed for a length of 2,080 feet, and in addition 595 feet were partly completed; the south jetty had been completed 1,077 feet, and partly completed for an additional distance of 223 feet, and its shore end had been strengthened by a durable sand-catch; the dike had been completed so far as was prudent at that time for its *safety*. It was 817 feet long, 5½ feet high above mean low water, except

L. OF ENGINEERS

that near its center a weir had been left 150 feet long and two feet above mean low water.

The 9 foot channel through the bar was 500 feet wide, and the least depth on the bar was 9.2 feet.

At the beginning of the year operations were in progress under a contract with the Rockport and Pigeon Hill Granite companies for the delivery in place in the north jetty of 10,000 tons, more or less, of rubble-stone at $1.97 per ton of 2,000 pounds. This contract was satisfactorily completed early in September, 1889, by the delivery of 9,999 tons of stone, of which 4,814 tons were delivered during the year.

At the date of this report the north jetty has been completed for 2,200 feet in length, and 475 additional are partly completed; the south jetty, the sand-catch, and the dike across Plum Island Basin remain as on June 30, 1889.

During the latter part of May and the early part of June, 1890, a survey of the bar and entrance of the harbor was made. The notes have been plotted and show that the channel inside of the outer ends of the jetties has widened slightly and deepened throughout, with no material change in its position; outside of the outer ends of the jetties the channel has swung still more to the southward, has an average width of about 800 feet between the 9-foot contours, with a least depth on the crest of the bar of 10.3 feet, or 1.1 feet deeper than in 1889.

Outside of the channel, near the high-water lines, extensive changes in the shore-lines and shoal contours have taken place, especially on the Plumb Island side, but in no way to affect the use of the channel. The deep water contours on the outside of the bar are almost identical with those of last year. The north and south breakers both show more regular outlines, and they act essentially as prolongations of the jetties. From notes furnished by Mr. Hiram F. Mills, engineer of the Essex Company, at Lawrence, Mass., it is known that an average of 18,200 cubic feet of water per second passed the dam at Lawrence during the months of March, April, and May, 1890; or a little more than the average for this season of the year.

To complete the improvement an appropriation of $142,500 will be required, all of which could be expended to advantage during the fiscal year ending June 30, 1892, in the extension of both jetties to their full projected lengths.

The advantages to be derived from the completion of the project are the deepening and widening of the channel across the bar, thereby affording a harbor of refuge on the inside of Salisbury Beach, and giving easy access at high tide to the wharves at Newburyport for vessels drawing 17 feet, approximately.

This work is located in the collection district of Newburyport, Mass., of which Newburyport is the port of entry. The nearest light-house is on Plum Island, at the entrance of the harbor.

The accompanying commercial statistics for the fiscal year ending June 30, 1890, have been furnished by the collector of customs for Newburyport, Mass.

Money statement.

July 1, 1889, amount available	$3,722.39
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	2,323.64
July 1, 1890, balance available	1,398.75
Amount appropriated by act of September 19, 1890	25,000.00
Amount available for fiscal year ending June 30, 1891	26,398.75

Amount (estimated) required for completion of existing project	$117,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	117,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Amount of revenue collected, $1,955.68.

Shipping.	Foreign.		Domestic.	
	No.	*Tons.*	*No.*	*Tons.*
Entrances	25	2,425	321	88,825
Clearances	41	6,411	309	85,384

Imported:	*Tons.*	Imported—Continued.	*Tons.*
Coal	208,000	Merchandise	240
Lumber	1,000	Miscellaneous	100

Schooners from 6 to 12 feet draught frequent the port.

No increase in the tonnage of the harbor is apparent since the improvement was commenced, and no new lines of water transportation have been established.

B 2.

IMPROVEMENT OF MERRIMAC RIVER, MASSACHUSETTS.

The mouth of the Merrimac River is 15 miles northwest from Cape Ann, Massachusetts. Tide-water extends up it a distance of 19 miles, or to the foot of the "Upper Falls," 1½ miles above Haverhill, Mass.

Seven incorporated cities and the largest mills in New England are directly interested in its improvement.

Before improvement the channel was narrow and crooked and much obstructed by ledges, bowlders, and shoals.

At mean low water vessels drawing not to exceed 7 feet could enter the river and proceed to South Amesbury, 9 miles from the mouth. The sea bar at the mouth of the river has been improved under specific appropriations for improvement of Newburyport Harbor, while many sunken rocks and wrecks of piers and vessels lying inside the bar have been removed by general appropriations for the improvement of the river.

The object of the Merrimac River improvement is to straighten, widen, and deepen the natural channel from the bar to the head of tide-water at the upper falls of a group known as Mitchell's Falls.

The rise or fall of the tide at the mouth is 7.7 feet; at Haverhill Bridge, 4 feet.

No plan of the river above Newburyport has been published in the Reports of the Chief of Engineers.

The project originally adopted in 1870 proposed to remove obstructions from the Upper and Lower Mitchell's Falls, and to remove the Gangway Rock and the "Boilers" in Newburyport Harbor. The cost was estimated to be $69,025. This project was modified in 1874 so as to include the removal of rocks in and near the draw of the bridge at Deer Island, 2 miles above Newburyport, and Rock's Bridge, and at Little Curriers Shoal, East Haverhill, so that the channel should have the following depths at ordinary high-water stages of the river: From

the mouth to Deer Island Bridge, 5 miles, 16½ feet; from Deer Island Bridge to Haverhill Bridge, 12½ miles, 12 feet; thence to the foot of Mitchell's Falls, Hazeltine Rapids, 1½ miles, 10 feet; through Mitchell's Falls to the head of the Upper Falls, 2½ miles, not less than 4½ feet, when the mill-water at Lawrence is running.

This revised project was estimated to cost $147,000.

The total appropriations to date have been $175,500.

The total expenditures to June 30, 1889, were $175,500.

The excess of expenditures over the estimate is due to the removal of rocks and other obstructions that were unknown and removal not contemplated when the estimate was made, and by the expense of necessary surveys and examinations not provided for in the estimate.

The condition of the improvement June 30, 1889, was as follows: The modified project of 1874 was completed with the exception of the removal of the "Boilers," upon which no work had been done.

During the year ending June 30, 1890, no active operations have been in progress.

The project, as modified in 1874, has been completed with the exception of the removal of the "Boilers," but from 1883–1886 additional improvements were recommended as follows:

For that part of the river below Mitchell's Falls—	
(1) To remove sunken rocks and shoals from Mitchell's Falls	$1,500
(2) To remove the "Boilers" to a depth of 5 feet at mean low water, 350 cubic yards at $25	8,750
Contingencies	1,250
Total	11,500

To extend the improvement so that the same depth of water as is now obtained through Mitchell's Falls can be carried to Lawrence (a distance of 5 miles from the head of the falls) was in 1882 estimated to cost for dredging through Gages' Shoal and Andover Bar, and removing bowlders and ledges, $11,000.

The improved channel is in good order.

This work is located in the collection district of Newburyport, Mass., of which Newburyport is the nearest port of entry. The nearest light-houses are the Plum Island Lights and the Newburyport Upper Harbor Lights. Commercial statistics are included in statement for Newburyport Harbor.

No increase in the tonnage of the river is apparent since the improvement was commenced, and no new lines of water transportation have been established.

Money statement.

Amount appropriated by act of September 19, 1890	$10,000.00
Amount (estimated) required for completion of existing project	1,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	1,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

B 3.

IMPROVEMENT OF POWOW RIVER, MASSACHUSETTS.

Powow River is a tributary of the Merrimac River, which it enters from the north, about 3½ miles above Newburyport. The tide enters the river a distance of about 9,600 feet, following the channel, or to a dam

just above the town of Amesbury, Mass. The present channel is narrow, exceedingly crooked, and is not navigable at low water. The mean range of the tide at the mouth of the river is 6.7 feet.

The general project for the improvement of this river was proposed January 24, 1885. It was based on the survey provided for in the river and harbor act of July 5, 1884. This project proposed to make a channel 9,600 feet long, 60 feet wide on the bottom, and 12 feet deep at mean *high* water, at an estimated cost of $77,000.

But one appropriation has been made for this improvement, viz, that by the river and harbor act of August 11, 1888, which appropriates $3,000 for dredging:

Provided, That this sum shall not be expended until the towns of Amesbury and Salisbury, or either of them, shall have caused such a draw to be placed in the present bridge over said river, as may be approved by the Secretary of War.

On August 25, 1888, the selectmen of the towns of Amesbury and Salisbury were notified of the requirements of the act and asked what action their respective towns would take in the matter.

On September 5, 1888, the selectmen of Salisbury stated that "no part of the Powow River is now within the limits of the town of Salisbury."

The selectmen of Amesbury submitted the matter at the town meeting March 23, 1889, and the town referred it to the selectmen and road commissioners as a joint body.

The selectmen instructed the Berlin Iron Bridge Company, of Berlin, Conn., to prepare plans for a new bridge with a draw-opening 36 feet in the clear.

On March 28, 1889, the Berlin Iron Bridge Company addressed a letter to the Secretary of War inclosing a plan of the proposed bridge for approval. This plan was approved by the Secretary of War, April 10, 1889, and on April 15, 1889, the town authorities were notified of this action.

No action has as yet been taken by the authorities which will warrant the expenditure of the funds available for this improvement.

To complete the improvement will require an appropriation of $74,000. Of this amount $30,000 could be expended to advantage during the fiscal year ending June 30, 1892, if the bridge at the mouth of the river shall have been rebuilt in accordance with the approved plans.

This work is located in the collection district of Newburyport, Mass., of which Newburyport is the nearest port of entry. The nearest light-houses are the Newburyport Upper Harbor Lights.

Commercial statistics are included in statement for Newburyport Harbor.

No increase in the tonnage of the harbor is apparent, and no new lines of water transportation have been established.

Money statement.

July 1, 1889, amount available	$3,000.00
July 1, 1890, balance available	3,000.00
Amount appropriated by act of September 19, 1890	5,000.00
Amount available for fiscal year ending June 30, 1891	8,000.00
Amount (estimated) required for completion of existing project	69,000.00
Amount that can be profitably expended in fiscal year ending June 30 1892	30,000.00

Submitted in compliance with requirements of sections 2 of river and *harbor acts of* 1866 and 1867.

B 4.

IMPROVEMENT OF IPSWICH RIVER, MASSACHUSETTS.

Ipswich River empties into Plum Island Sound, 9 miles south of Newburyport, Mass., and at the same distance west of Cape Ann. The head of navigation is 3 miles above the mouth.

The entrance of Plum Island Sound is 2 miles east of the mouth of the river. Six feet depth at mean low water can be carried over the bar at the entrance to the sound, and between the bar and the mouth of the river there is a good anchorage, with from 3 to 5 fathoms of water.

Before improvement the channel of the river from its mouth to "Barras Turn," a distance of 2 miles, was at least 60 feet wide and 4 feet deep at mean low water. From "Barras Turn" to the town wharves, a distance of 1 mile, the channel was narrow and crooked, and had at some places but 1½ feet depth at mean low water. The mean rise or fall of the tide is 8.4 feet.

The original project for improvement was submitted December 6, 1875. It proposed a channel 60 feet wide and 4 feet deep, mean low water, from "Barras Turn" to the town wharves, at an estimated cost of $25,000.

On November 5, 1883, the original project was divided into three partial projects:

1. The removal of the ledges at Heard's Point, and opposite Nabby's Point, to a depth of 2 feet at mean low water, to open a navigable channel of that depth, at a cost of $15,900.

2. To dredge the shoals at "Labor in Vain" and "The Shoals," so as to open a channel 4 feet deep at mean low water and 60 feet wide, at a cost of $2,200.

3. To straighten the channel by making a cut across "Barras Turn," and to build a jetty to close the old channel, at a cost of $6,900.

In the Annual Report of 1887 it was recommended that the general project be modified by limiting the present improvement to opening a channel 60 feet wide and 4 feet deep through "The Shoals" and "Labor in Vain," and extending it to the "Deep Hole" opposite the town wharves.

A chart showing this limited project was published in the report of the Chief of Engineers for 1887.

The amount which has been appropriated for this improvement to date is—

By the act of August 5, 1886	$2,500
By the act of August 11, 1888	2,500
Total	5,000

The amount expended to June 30, 1889, was $2,500, and a channel had been dredged 4 feet deep at mean low water, 60 feet wide at "Labor in Vain," and 40 feet wide at "The Shoals."

During the year ending June 30, 1890, the operations for the improvement of the river were as follows: The Chief of Engineers, on September 6, 1888, had authorized the expenditure of the funds available for this improvement in dredging 6,000 cubic yards from "The Shoals" and the cut connecting with the "Deep Hole," opposite the town wharves. The work had been advertised, and the one bid received and opened November 1, 1888, had been rejected as excessive.

On September 27, 1889, sealed proposals were invited by circular letter for the proposed work, and no bids were received. On April 10,

1890, proposals were again invited by circular letter, and on April 21, 1890, the two bids received were opened; an abstract of them will be found in the annexed table.

The lowest bid would make the work cost twice the amount available, and, therefore, by authority of the Chief of Engineers, the bids were rejected.

It is evident from the small amount of work to be done in this place, so difficult of access, that its cost will be largely in excess of similar work in more accessible places. The improvement already made does not reach the town wharves, and will be of little benefit to commerce unless extended. To effect this will require an appropriation of $2,500 in addition to funds now available.

The condition of the improvement at date is the same as on June 30, 1889.

To complete the original project would require an appropriation of $20,000, but the present proposed partial project, it is believed, will fully meet all the reasonable demands of the present commerce of the river.

Ipswich River is in the collection district of Newburyport, Mass. The nearest lighthouse is the Ipswich Light, on Castle Neck, about 1¼ miles southeast from the mouth of the River.

Commercial statistics are included in the Newburyport Harbor.

No increase in the tonnage of the river is apparent and no new lines of water transportation have been established.

Money statement.

July 1, 1889, amount available	$2,467.92
July 1, 1890, amount expended during fiscal year exclusive of liabilities outstanding July 1, 1889	5.00
July 1, 1890, balance available	2,462.92
Amount (estimated) required for completion of existing project	20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	2,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals for dredging in Ipswich River, Massachusetts, opened April 21, 1890, by Lieut. Col. S. M. Mansfield, Corps of Engineers, U. S. Army.

No.	Name of bidder.	Price bid for dredging per cubic yard measured in scows.	Price bid for removal of bowlders per cubic yard.	Remarks.
1	Eastern Dredging Company by J. H. Gerrish, agent.	$0.95	$10.00	For dredging above Heard's Point.
		.45	.....	For dredging below Heard's Point.
2	Thomas Symonds	.55	15.00	For bowlders weighing over 3 tons.
		1132	.....	

Bids rejected, with the approval of the Chief of Engineers.

B 5.

HARBOR OF REFUGE, SANDY BAY, CAPE ANN, MASSACHUSETTS.

Sandy Bay is situated at the northeastern extremity of the promontory of Cape Ann, which forms the northern limit of Massachusetts Bay. The shore-lines of the bay form a little less than a right angle,

and their directions are nearly north and south and east and west. The rocky island of Straitsmouth forms the eastern extremity of one shore-line, and the steep headland of Andrew's Point the northern end of the other.

Following the line of the proposed breakwater, the bay is 2¾ miles wide, and it has a depth of 2 miles, approximately.

The bay on the land side is perfectly protected by steep, high hills, but it fronts the northeast, and is open to the full force of the violent northerly and easterly gales of this coast.

The great seas of the ocean are broken, however, in a degree by the sunken rocky ledges called Avery's Ledge, the Dry and Little Salvages, the Flat Ground, and Abner's Ledge, which are directly at the mouth of the bay. Inside these entrance ledges the bay is entirely unobstructed, and has an average depth of 50 feet at mean low water.

A plan of the bay showing the proposed breakwater was published in the Annual Report of the Chief of Engineers for 1886, page 582.

The project for improvement was submitted in 1884. It proposes a continuous breakwater 9,000 feet long, divided into two branches; one starts at Avery's Ledge and runs in a direction a little west of north to Abner's Ledge, a distance of 3,600 feet; the other extends 5,420 feet from Abner's Ledge in a northwesterly direction, and terminates at the 83-foot contour off Andrew's Point.

The axis of the proposed breakwater is approximately at the inner edge of the ledges at the entrance of the bay, and about 1 mile inside the Salvages and Flat Ground, which receive the first shock of easterly storm waves.

The southern entrance to the proposed harbor lies between Straitsmouth Island and Avery's Ledge, and is to be 1,800 feet wide and at least 30 feet deep. The northern entrance, near Andrew's Point, is 2,700 feet wide and 80 feet deep.

They are so located with reference to each other that vessels can enter and leave the harbor with any wind.

The harbor formed by the breakwater covers an anchorage of 1,377 acres, in which the depth exceeds 24 feet at mean low tide.

The breakwater will be formed to the level of 22 feet below low water, of a mound of broken stone, 40 feet wide at top, above which a masonry wall has been suggested, the crest of which shall be 15 feet wide and 8 feet above extreme high water. The detailed plan for the construction of the masonry wall has not been definitely adopted, and operations have been confined to the construction of the rubble-stone mound, or substructure of the breakwater. This is effected by dropping stone from vessels and self-dumping scows along the axis of the breakwater, extending to the eastward and westward, a distance of 20 feet approximately. The axis is indicated by an iron spindle on Avery's Ledge, when in range with the south light-house on Thatcher's Island; cross ranges are established by iron pipes let into the rocks on Dry and Little Salvages, which mark points at intervals of 100 feet from the spindle (initial point) on Avery's Ledge.

The estimated cost of the improvement is $5,000,000, to which must be added $2,500,000 for buoyage, lighting, and defense of the harbor.

These estimates are based upon consecutive annual appropriations of not less than 10 per cent. of the original estimates of cost.

Should operations be suspended at any time from want of funds, or annual appropriations be reduced to small sums for a series of years, the expenses for the final construction will be proportionally increased.

The amount which has been appropriated to date is $300,000.

The total amount expended to June 30, 1889, inclusive of outstanding liabilities, was $231,761.78.

On June 30, 1889, 284,899 tons of rubble-stone had been deposited in the substructure of the breakwater, which essentially completed it between cross-ranges 140 and 2940.

As was to be expected from the nature of the work, the top of the mound was found to be somewhat irregular, and the depth of water over it varied from 18 to 23 feet.

At the beginning of the fiscal year, operations were in progress under a contract with the Rockport and Pigeon Hill Granite companies to deliver 110,000 tons of rubble-stone, at 71 cents per ton, deposited in the breakwater. This contract was satisfactorily completed in June, 1890, 110,000 tons were delivered under this contract, of which 68,035 tons were received during the fiscal year.

The total number of tons of rubble-stone deposited in the breakwater to date is 352,934, and the substructure of the breakwater is essentially completed between cross-ranges 140 and 3540.

This last cross-range (3540) is the proposed axis of the north branch of the breakwater; and, as economy in its construction may result from a slight shifting of the axis, north or south, to better fit the existing bottom, a detailed survey of the proposed location of this branch has been commenced, and it will be extended over the eastern or completed branch of the substructure, in order that comparisons may be made with previous surveys, and the rate of settlement or other changes noted.

To complete the project will cost $4,700,000, approximately.

During the fiscal year ending June 30, 1892, $250,000 could be expended to advantage in the extension of the substructure of the breakwater.

The prospective benefits to commerce and navigation by the construction of this harbor of refuge are increased safety to life and property, and a consequent reduction in freight and insurance.

Sandy Bay is situated in the collection district of Gloucester, Mass.

The nearest light-house is Straitsmouth Light, situated on Straitsmouth Island, at the southern entrance of the bay.

The accompanying commercial statistics for the fiscal year ending June 30, 1890, have been furnished by the collector of customs at Gloucester, Mass.

Money statement.

July 1, 1889, amount available		$19,933.37
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$7,657.26	
July 1, 1890, outstanding liabilities	41.67	
		7,698.93
July 1, 1890, balance available		12,234.44
Amount appropriated by act of September 19, 1890		150,000.00
Amount available for fiscal year ending June 30, 1891		162,234.44
Amount (estimated) required for completion of existing project		4,550,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892		250,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

The vessels frequenting this port are schooners.

Tonnage for year ending June 30, 1885 (page 521, Chief of Engineers' Report, 1885), 5 vessels, 500 tons.

Tonnage for year ending June 30, 1890, as given by collector of port, 3 vessels, 175 tons.

B 6.

IMPROVEMENT OF HARBOR AT GLOUCESTER, MASSACHUSETTS.

This is the most important harbor between Boston and Portland, and is the principal resort for all New England fishing vessels. It is situated at the southeastern extremity of Cape Ann, 20 miles northeast from Boston. It is easily entered when the dangerous storms of this coast occur, and provides a secure ample shelter for all classes of vessels except from south winds, and from these a moderate extent of protected anchorage is afforded in the inner harbor.

It contains in the outer roadstead, the inner harbor, and in the channel connecting them, sufficient deep water for the most liberal demands of commerce; but the inner harbor and channel are obstructed by bowlders, ledges, and shoals, dangerous and inconvenient to shipping, and the outer harbor or roadstead is open to the action of all southerly winds.

A plan of the harbor was published in the Annual Report of the Chief of Engineers for 1887, page 506.

The first project formed for improvement was submitted January 20, 1871, and was based on the survey ordered by the act of July 11, 1870. (Report of the Chief of Engineers, 1871, page 869.)

This project proposed the removal of certain bowlders from the inner harbor at a cost of $10,606.20, and the construction of a breakwater from Eastern Point over Dog Bar to Round Rock Shoal, at an estimated cost of $494,148.65.

On November 19, 1884, Maj. C. W. Raymond, Corps of Engineers, by order of the special Board of Engineers that was considering the subject of the Sandy Bay Breakwater, submitted a project for two breakwaters at the entrance of Gloucester Harbor, one to cost $752,000 on essentially the same site as that proposed in 1871; and a supplementary one through Norman's Woe Rock, to cost $607,000.

This project and estimate are published in the Chief of Engineers' Report for 1885, page 534.

On January 20, 1885, it was recommended, in accordance with act of July 5, 1884, that a survey of the inner harbor and of the reef off Muscle Point be made, and that Babson's Ledge be removed to 21 feet at mean low water. (Report of Chief of Engineers', 1885, page 541.) In the annual report for this harbor for 1887, a general project for its improvement was submitted, based on the survey provided for by act of Congress approved August 5, 1886. (Chief of Engineers' Report, 1887, page 500.)

This project proposed to remove from the inner harbor 101½ cubic yards of rock known to exist, and to dredge 216,000 cubic yards, scow measurement, at an estimated cost of $65,000; and to construct the breakwater recommended in the project of 1884, that extends from Eastern Point to Round Rock Shoal, at an estimated cost of $752,000.

The total appropriations for this harbor to date have been $25,000.

The amount expended to June 30, 1889, was $24,326.46.

The condition of the improvement June 30, 1889, was as follows: Clam Rock had been reduced from 1 foot to 9½ feet at mean low water; Pinnacle Rock from 8½ to 16½ feet, mean low water; rock off Pew's Wharf from 2 to 5 feet, mean low water; rocks off J. Friend's Wharf, from 13 to 17 feet, mean low water. All of the above rocks were reduced to the level of the surrounding bottom.

Babson's Ledge had been reduced from 11 to 14 feet, mean low water. No work had been done on the breakwater.

Two channels had been dredged in Harbor Cove, approximately parallel to the heads of the wharves; the east channel was 550 feet long, the west, 1,000 feet long; both were 40 feet wide and 10 feet deep at mean low water, except over a small ledge uncovered by the dredging off Parmenter's Wharf.

All the ledges obstructing the channel in the main harbor between Harbor Cove and Pew's Wharf had been removed to the depth of the projected dredging in this part of the harbor.

No operations were in progress during the year, owing to want of funds.

To complete the improvement would require an appropriation of $55,000 for dredging, and $752,000 for the breakwater at Eastern Point. Of this amount $305,000 could be expended to advantage during the fiscal year ending June 30, 1892, in completing the proposed dredging and in commencing the breakwater.

The prospective advantages to commerce by the completion of the improvement are greater facilities and safety in the movement of vessels in the harbor, and a more secure anchorage for vessels seeking protection from southerly gales.

Gloucester Harbor is in the collection district of Gloucester, Mass., of which Gloucester is the port of entry.

The nearest light-houses are Ten Pound Island Light, in the harbor, and Eastern Point Light, at its entrance.

The accompanying commercial statistics for the fiscal year ending June 30, 1890, have been furnished by the collector of customs at Gloucester, Mass.

Money statement.

July 1, 1889, amount available	$433.54
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	14.38
July 1, 1890, balance available	419.16
Amount appropriated by act of September 19, 1890	15,000.00
Amount available for fiscal year ending June 30, 1891	15,419.16
Amount (estimated) required for completion of existing project	792,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	305,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Amount of revenue collected during year ending June 30, 1890, $50,464.23.

Shipping.	Foreign.			Domestic.	
	Number.	Tonnage.	Value.	Number.	Tonnage.
Entrances	136	29,138	$96,870	22	2,149
Clearances	123	16,130	8,000	41	13,034

Salt imported, 28,324 tons.

Vessels of all sizes frequent this port.

Tonnage for year ending June 30, 1870 (page 871, Chief of Engineers' Report, 1871), 226 vessels, 24,528 tons, entered; 155 vessels, 19,377 tons, cleared.

Tonnage for year ending June 30, 1890, as given by collector of port, 158 vessels, 31,287 tons, entered; 164 vessels, 29,164 tons, cleared.

Since the improvement was commenced, salt is imported by steam-ships.

B 7.

IMPROVEMENT OF HARBOR AT MANCHESTER, MASSACHUSETTS.

Manchester Harbor is situated about 5½ miles northeastward from the entrance of Salem Harbor, Massachusetts.

A chart of the harbor was published in the Annual Report of the Chief of Engineers for 1888, Part I, page 466.

The outer sheltered roadstead contains approximately 300 acres, with 5 fathoms of water.

The entrance channel from the roadstead to Proctor's Point is everywhere at least 100 feet wide, at least 6½ feet deep at mean low water, and is unobstructed.

At the "Narrows," distant 1,400 feet inside of Proctor's Point, the depth in the channel is reduced to 1½ feet at mean low water; thence to the town wharves, a further distance of 2,500 feet, no low water channel exists. Near the town wharves the channel is crossed by the Boston and Maine Railroad (eastern division), on a bridge which is provided with a draw opening 28 feet wide.

The original project for the improvement of this harbor was submitted November 28, 1887. It was based on a survey provided for in the river and harbor act of August 5, 1886. It proposed to dredge a channel 60 feet wide, 4,000 feet long, and 4 feet deep at mean low water from Proctor's Point to the town wharves, at an estimated cost of $14,300.

But one appropriation has been made for this improvement, that by the act of August 11, 1888, $2,500.

On November 22, 1888, it was recommended that the money appropriated for this improvement be retained in the Treasury until further funds are available.

This recommendation was approved the Chief of Engineers, November 26, 1888.

No other operations have been in progress during the year ending June 30, 1890, and the harbor remains in its original condition.

To complete the improvement will require an appropriation of $11,800.

all of which could be expended to advantage during the fiscal year ending June 30, 1892.

Manchester Harbor is in the collection district of Gloucester, Mass., of which Gloucester is the port of entry. The nearest light-house is situated upon Baker's Island, 2¼ miles from Proctor's Point.

The existing commerce is nominal, and the commercial statistics are included in Gloucester Harbor.

No increase in the tonnage of the harbor is apparent, and no new lines of water transportation have been established.

Money statement.

July 1, 1889, amount available	$2,396.93
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	6.00
July 1, 1890, balance available	2,390.93
Amount appropriated by act of September 19, 1890	5,000.00
Amount available for fiscal year ending June 30, 1891	7,390.93
Amount (estimated) required for completion of existing project	6,800.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	6,800.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

B 8.

IMPROVEMENT OF HARBOR AT LYNN, MASSACHUSETTS.

Lynn Harbor is situated 9 miles northeast from Boston. It is 1 by 2 miles approximately in extent, the greater part of which is dry at low water.

It is protected on the north and west by the mainland and on the east by Nahant Beach, and its entrance, 2 miles wide, into Massachusetts Bay, is on the south side.

A plan of the harbor showing the projected improvement was published in the Annual Report of the Chief of Engineers for 1884, part I, page 532.

Before improvement three narrow and crooked channels of approach to the wharves existed, in each of which there was about 6 feet depth at mean low water. The mean rise or fall of the tide is 9.3 feet.

The western channel leads to the Point of Pines and the mouth of Saugus River. The main ship-channel is entered between White and Lobster rocks, and connects about 3,600 feet northward with the Black Rock Channel, which is the most eastern near Nahant Beach.

The project for improvement was adopted in 1884. It provides for the excavation of a channel 200 feet wide and 10 feet deep at mean low water, from a point near and east of the White Rocks to deep water opposite Little Nahant, a distance 3,610 feet; this is called the outer improved channel and is merely a rectification and deepening of the main ship-channel. The combined main ship and Black Rock channels are sufficient for the purposes of commerce for the next 2,500 feet. Then commences the inner improved channel, which is projected 6,450 feet long, 200 feet wide, and 10 feet deep at mean low water. It extends from deep water opposite Sand Point to the harbor commissioners' line, and follows very closely in direction the extension of the united main ship and Black Rock channels.

On September 24, 1888, this project was modified. It was then proposed to extend the main ship-channel 400 feet within the harbor line, and to excavate at its inner end a basin 500 by 300 feet in area, 10 feet deep at mean low water.

It is supposed that the inner channel will need to be dredged occasionally to maintain its width and depth; but a training-wall, about 6,000 feet long, has been proposed, to aid in keeping the outer channel open, if experience shall show it to be necessary.

This wall is to start from the shore at "Little Nahant," and is to cross the Black Rock Channel. Its outer portion is to be parallel to the outer improved channel.

The cost of the original project was estimated to be $145,000. This estimate was revised in 1885, and then made $157,000, to provide for an increased amount of dredging found to be necessary during the progress of the work, to round off the junctions of the natural channel with the dredged channel, to provide flatter slopes to the sides of the cuts than was originally designed, and also to provide funds for necessary surveys during the progress of the work.

The modifications proposed September 24, 1888, were estimated to cost $25,000, which would make the total cost of the improvement $182,000.

The total appropriations for this harbor to date have been $76,000.

The amount expended to June 30, 1889, was $66,015.92.

On June 30, 1889, the outer channel had been completed as proposed, 3,610 feet long, 200 feet wide, 10 feet deep at mean low water; the inner channel was 6,450 feet long, 10 feet deep at mean low water, 150 feet wide, or 50 feet less than is proposed. A contract was in force with the Bay State Dredging Company to dredge 28,000 cubic yards, part of which might be dredged from the western channel.

The price to be paid for dredging from the main ship-channel was 29 cents, and from the western channel 45 cents per cubic yard, scow measurement.

During the latter part of June, 1889, a survey of the western channel was made and it showed that to give a navigable channel 150 feet wide and 8 feet deep at mean low water would require the removal of 16,000 cubic yards by dredging, at a cost of $8,000.

From the nature of the work, a shallow cut through a sandy sea bar, there was no hope that it would be permanent, and it was decided to expend the whole of the funds available for this harbor in the continuation of the improvement of the main ship-channel, under the revised project of September 24, 1888.

Operations under the contract with the Bay State Dredging Company were commenced in September, 1889, and completed in November, 1889, by the removal of 25,571 cubic yards of material from the main ship-channel and the basin.

The basin was excavated 125 feet wide, 500 feet long, 10 feet deep at mean low water, and was connected with the main ship channel at the harbor-line by a cut 100 feet wide, 400 feet long, 10 feet deep at mean low water. No other operations were in progress during the year, and the condition of the inner and outer main ship-channels is essentially as stated in the last report.

To complete the improvement will require an appropriation of $91,000, and of this amount $50,000 could be expended to advantage during the fiscal year ending June 30, 1892.

Lynn is a port of entry in the collection district of Marblehead, Mass.
The nearest light-house is Egg Rock (Nahant) Light, 3 miles distant.

The accompanying commercial statistics for the fiscal year ending June 30, 1890, have been furnished by the collector of customs at Marblehead, Mass.

Money statement.

July 1, 1889, amount available	$1,635.58
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,050.90
July 1, 1890, balance available	584.68
Amount appropriated by act of September 19, 1890	15,000.00
Amount available for fiscal year ending June 30, 1891	15,584.68
Amount (estimated) required for completion of existing project	76,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	50,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Amount of revenue collected, $3,509.60.

Shipping.	Foreign.		Domestic.	
	No.	*Tons.*	*No.*	*Tons.*
Entrances	28	2,692	489	97,800
Clearances	38	4,735	477	95,400

Imported:			Lumber	feet	8,248,000
Coal	tons	146,000	Potatoes	bushels	8,200
Iron	do	1,400	Miscellaneous	tons	16,000

Vessels of all kinds less than 18 feet draught frequent the harbor.

Tonnage for year ending June 30, 1883 (Chief of Engineer's Report, 1883, page 462), 589 vessels, 99,569 tons.

Tonnage for year ending June 30, 1890, as per collector's statement, 517 vessels, 100,492 tons.

No new lines of transportation have been established since the improvement was commenced.

B 9.

IMPROVEMENT OF HARBOR AT WINTHROP, MASSACHUSETTS.

This harbor is situated in the northeastern part of Boston Harbor, immediately westward of Winthrop Head.

A chart of the harbor was published in the Annual Report of the Chief of Engineers for the year 1888, part 1, page 470.

The harbor contains, approximately, 350 acres, all of which is dry at low tide except a short, narrow, crooked slough east of Snake Island. To the town wharf no low-water channel exists. The mean range of tides is 9.4 feet.

The nearest deep-water channel of Boston Harbor is known as the "Back" Channel, and it extends from Point Shirley to East Boston. It has from 9 to 16 feet depth at low tide. The town wharf is distant from this "Back" Channel 3,900 feet.

The original project for the improvement of this harbor was submitted

November 28, 1887; it was based on the survey provided for in the river and harbor act of August 5, 1886.

The project proposes to excavate a straight channel 3,900 feet long, 50 feet wide, and 6 feet deep at mean low water, from the "Back" Channel to "Rice's" Wharf, at an estimated cost of $17,600.

But one appropriation has been made for this improvement, viz, $1,000 by the river and harbor act of August 11, 1888.

On August 24, 1888, it was recommended that the amount available for this improvement be retained in the Treasury until additional funds are provided. This recommendation was approved by the Chief of Engineers September 17, 1888.

No operations have been in progress during the year ending June 30, 1890, and the original condition of the harbor is unchanged.

The beaches and headlands protecting this harbor on the east were seriously abraded by the storms of the winter 1888–'89; this abrasion has been continued and they will soon require protection, not only to secure this minor harbor, but to prevent injury to the main harbor of Boston. To complete the improvement will require an appropriation of $16,600, all of which could be expended during the fiscal year ending June 30, 1892.

Winthrop Harbor, Massachusetts, is in the collection district of Boston, Mass., of which Boston is the port of entry; the nearest light-house is situated upon Deer Island Point, Boston Harbor, Massachusetts.

The existing commerce is nominal, and commercial statistics are included in Boston Harbor, Massachusetts.

No increase in the tonnage of the harbor is apparent, and no new lines of water transportation have been established.

Money Statement.

July 1, 1889, amount available	$1,000.00
July 1, 1890, balance available	1,000.00
Amount appropriated by act of September 19, 1890	5,000.00
Amount available for fiscal year ending June 30, 1891	6,000.00
Amount (estimated) required for completion of existing project	11,600.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	11,600.00

Submitted in compliance with requirements of sections 2, of river and harbor acts of 1866 and 1867.

B 10.

IMPROVEMENT OF HARBOR AT BOSTON, MASSACHUSETTS.

Boston Harbor consists essentially of an inner and an outer harbor, united by a deep water-way, and each accessible from the sea by a distinct channel, widening into a deep and spacious roadstead.

1. *Inner Harbor.*—This harbor lies to the north and westward of Long Island, and has deep water and a good anchorage in the President Roads, seaward of Lower Middle Bar, and also near the city westward of Upper Middle Bar.

Four rivers discharge their waters into this basin: the Charles, Mystic, and Chelsea rivers from the north, and the Neponset from the south. The direct entrance from the sea is by Broad Sound.

2. *Outer Harbor.*—This harbor lies to the southward of Long Island and has a fine anchorage in Nantasket Roads, as well as in Hingham Bay, a well sheltered harbor southeast of Paddock Island. It connects with the inner harbor by the main ship-channel through the "Narrows," and by secondary channels east and west of Long Island. It is reached from the sea by Nantasket Roads, which lie south of George's and Great Brewster islands, and is marked at the sea entrance by Boston Light.

Weymouth and Weir Rivers empty into the Outer Harbor.

Both the inner and outer harbors are subdivided into several minor harbors, and contain many islands which shelter the anchorages from winds and storm waves.

The range of tides at the navy-yard is 9.8 feet, and at the entrance to the outer harbor 9.4 feet.

A sketch of the harbor was printed in the Annual Report of the Chief of Engineers for the year 1888, page 454.

The object of the improvement is, first, to *preserve* the harbor by protecting the islands and headlands; and, second, to *improve* it by widening, deepening, and straightening the channels.

The projects adopted for this purpose since 1866 have been mainly in accordance with the recommendations of the United States commissioners, whose labors terminated during that year.

The works of preservation consist of sea-walls, aprons, jetties, etc., which protect the shores of the islands and headlands, prevent additional wash into the channels, control the tidal scour, and preserve the full height of anchorage shelter for vessels in the roadsteads.

The works of improvement have been by dredging and blasting.

The total expenditures to June 30, 1889, were $1,711,327.16 (inclusive of outstanding liabilities).

WORKS OF PRESERVATION.

Point Allerton.—This headland at the southeasterly entrance of the harbor is protected by a granite sea-wall 1,202 feet in length, completed in 1873. Its concrete foundation for a distance of 1,005 feet is protected by an apron and 8 short jetties of granite rubble-stone.

No work was done on it during the fiscal year. Its condition June 30, 1890, is as follows: The wall is generally in good order, although some of its joints should be repointed. The bluff protected by this wall is not fully covered from storm-action, and the sea-wall should be extended westward for a distance of at least 150 feet, and the foundation of the extension should be protected with riprap.

This is estimated to cost $15,000.

Great Brewster Island.—This island is on the north side of the main ship-channel near the entrance. It is protected by a granite sea-wall 2,840 feet long, which was completed in 1869. No work was done on it during the fiscal year, and on June 30, 1890, it was in fair order. Many of the joints require repointing, and some of the coping-course should be reset. These necessary repairs are estimated to cost $10,000.

George's Island.—Its northern and eastern shores are protected by a granite sea-wall 2,150 feet long. West of this wall a riprap improvement extends for 450 feet, and south of it another 600 feet long. The sea-wall and southern riprap were built about 1835. The western riprap was built in 1884–'85. No work was done on the wall or ripraps during the year, and they are in good order at the date of *this report.* The unprotected western shore-line of the island, in front

of the Government buildings, was considerably abraded; the high-water line had been moved back in places nearly 25 feet. This shore-line should be protected by a light sea-wall, 1,400 feet long, at a cost of $35,000.

Lovell's Island.—The western shore of this island is protected by a rubble-stone apron 975 feet long, built in 1873, and repaired and extended in 1884; the northern shore is covered by a granite sea-wall 750 feet long, built in 1843, and the eastern shore is protected by a granite sea-wall 800 feet long, built in 1869 and repaired in 1879 and 1886, and by two rubble-stone aprons, one between the northern and eastern sea-walls, 1,440 feet long, and the other south of the east sea-wall, 1,330 feet long. No operations were in progress during the fiscal year.

The condition of the work on June 30, 1890, was as follows: The sea-walls and the ripraps on the eastern shore were in good order; the western shore riprap had been undermined in places and had fallen down, but it needed no immediate repairs.

Gallop's Island.—The western, northern, and eastern shores of this island are protected by a granite sea-wall 1,785½ feet long, completed in 1871, and by a rubble-stone apron completed in 1884, 3,050 feet long, which also covers the foundation of the sea-wall.

On June 30, 1889, operations were in progress in extending the sea-wall 300 feet to the southeast. The granite ashlar and shell-stone paving for this extension had been purchased by contract with the Pigeon Hill Granite Company. The extension was built by hired labor, and it was completed in October, 1889, at a cost of $13,850.31.

On June 30, 1890, the condition of this improvement was as follows: The walls and ripraps were in good order, but the shore from the end of the extension of the wall to the west wharf had been seriously abraded and needed the protection of a light sea-wall, which is estimated to cost $12,000.

Deer Island—Three prominent bluffs of this island are protected by granite sea-walls originally built about 1827. The north head-wall is 1,740 feet long; the middle head-wall is 840 feet, and the south head-wall is 380 feet long. In 1865 and 1869 these walls were partly rebuilt, and in the weakest places were backed with concrete. They were all originally built dry, and from time to time have required repairs. During the winter 1888–'89 the north and middle head-walls were seriously injured by storms. During the fiscal year repairs were made to the middle and north head walls by hired labor. One hundred and fifty feet of the middle head-wall was relaid and backed with concrete, and 130 feet of the coping course was reset. At the north head-wall 400 running feet of the coping course were reset, as was also nearly all of the shell-stone paving in rear of this part of the wall. Operations were suspended at the close of the working season.

The amount expended during the year was $3,711.97, and the balance of the allotment, $2,288.03, will be expended in pointing and minor repairs. The walls are in fair order at the date of this report.

Long Island.—The north head of this island is protected by a granite sea-wall 2,081¾ feet long, completed in 1874. Part of the foundation of the sea-wall and of the beach at both its ends are protected by a rubble-stone apron, aggregating 1,375 feet in length. This apron was built in 1874 and extended in 1884. No operations were in progress during the fiscal year. On June 30, 1890, the wall needed to be repointed in places, the riprap was in fair order and should be extended about 250 feet to more fully protect the southeastern shore; these repairs and extensions are estimated to cost $3,000.

Rainsford Island.—The north head of this island is protected by a dry granite sea-wall 1,500 feet long, originally built about 1840 and extensively repaired in 1884–'85. No work was done during the year, and on June 30, 1890, the wall was in good order and needed no repairs.

Castle Island.—The north and part of the east and west shores of this island are protected by a dry granite sea-wall 3,300 feet long, built in 1835. A light riprap extends along the east shore 300 feet from the end of the wall; this was built in 1865. No work was done during the year, and on June 30, 1890, the riprap was in good order. The sea-wall needed repairs on the north face a short distance west of the wharf where the foundation has been undermined and the wall has settled. About 100 running feet of the wall has been thus injured, and this length of the wall needs taking down and rebuilding, at a cost of $1,000.

Governor's Island.—The shore-line of this island has never been protected. The east and south bluffs, however, should be covered by sea-walls to prevent any additional abrasion, not only to secure the sites of the important heavy batteries which occupy these bluffs, but also to prevent injury to the main ship channel.

The east bluff wall should be 500 feet long, and is estimated to cost $30,000; the south bluff wall should be 1,800 feet long, and will cost $50,000.

WORKS OF IMPROVEMENT.

The main ship-channel.—Before improvement it had a least width of 100 feet and a least depth of 18 feet at mean low water. The general project for its improvement was submitted in 1867. It proposed to dredge the channel 23 feet deep at mean low water, 1,000 feet wide at the "Upper" and "Lower" Middles, and 685 feet wide at the "Narrows."

In 1870 the proposed width at the Narrows was reduced to 625 feet, and at Anchorage Shoal, in the inner harbor, increased to 1,100 feet.

In 1887 it was proposed to straighten the passage through the "Narrows" by cutting off a spur that projected from Lovell's Island, which was estimated to contain 20,000 cubic yards.

On June 30, 1889, the condition of the main ship-channel was as follows: It was 23 feet deep at mean low water, 1,100 feet wide west of the "Upper Middle," 750 feet wide at the "Upper Middle," 1,000 feet wide at the "Lower Middle," and 625 feet wide at the "Narrows." In effecting this improvement dredging and blasting was done at the following places:

At Nash's Rock Shoal, during the years 1876–1878, 365 cubic yards of ledge were removed.

At Kelly's Rock and Shoal, during the years 1869–1879, 222 cubic yards of ledge were removed.

Tower, Corwin, and Channel Rocks were removed during the years 1867–1875. They aggregated 608¾ cubic yards.

From the west end of Brewster's Spit, during the years 1874–1876, 29,226 cubic yards of sand and gravel were dredged and 95½ cubic yards of ledge were removed.

At Lovell's Island, from the southeast and southwest points, 267,294½ cubic yards were dredged during the years 1867–1877, and from a spur between these points 3,430 cubic yards were dredged in 1888.

At Castle Island Bar and Shoal, opposite the Lower Middle, during the years 1880–1883, 36,957 cubic yards were dredged and 20 tons of rock were removed.

At the Lower Middle, in 1874–1875, State and Palmyra rocks were

removed; they aggregated 62 cubic yards. In 1887–1889 71,892 cubic yards were dredged from this shoal and 375 cubic yards of ledge removed.

At the Upper Middle, during the years 1870–1876, 268,278½ cubic yards were dredged and 118½ cubic yards of ledge were removed; in 1883–1889 140,240 cubic yards were dredged.

At Anchorage Shoal, during the years 1879–1882, 65,327 cubic yards were dredged.

At Man-of-War Shoal 85,917 cubic yards were dredged in the years 1878–1880.

At Mystic River Shoal, during the years 1879–1882, 82,082, cubic yards were dredged.

At the commencement of the fiscal year a contract was in force, which was entered into November 23, 1888, with the New England Dredging Company, to remove 170,000 cubic yards, more or less, from the "Upper" and "Lower" middles. Operations under this contract had been suspended on May 3, 1889, until surveys and estimates could be made for the removal of small ledges uncovered by the dredging. These ledges were found to contain 111 cubic yards above the plane of 23 feet at mean low water. The contract of November 23, 1888, was finally closed by a supplementary agreement on August 31, 1889. The total number of yards dredged under the contract was 152,498, of which 6,316 yards were removed from the Lower Middle and 140,240 yards from the Upper Middle during the year 1888–'89; the balance of 5,942 yards was taken from the Upper Middle during the year ending June 30, 1890, in removing shoal spots and rounding corners of the cuts made in 1888–'89.

On November 6, 1889, sealed proposals were invited by public advertisement for the removal of the 111 cubic yards of ledge uncovered by the dredging at the Upper Middle. The one bid received (for an abstract see annexed table) was accepted by the Chief of Engineers, and on December 17, 1889, a contract for this work was entered into with Mr. George W. Townsend. Operations under this contract were commenced during the last week in April, 1890, and the work was satisfactorily completed in June, 1890.

To complete the approved project for the improvement of the main ship-channel at the Upper Middle will require an appropriation of $200,000, all of which could be expended to advantage during the fiscal year ending June 30, 1892.

The general survey of the outer harbor, which was completed in 1889, indicated that the west end of Brewster Spit was still encroaching on the main ship-channel opposite George's Island Shoal. This spit was dredged in 1874–1876, and the channel was then at least 625 feet wide, 23 feet deep at mean low water. During the present year a detailed survey of this part of the channel was made, and by a comparison with the survey of 1876 it is found that 51,225 cubic yards have been deposited outside of the line of dredging done in 1876.

Of this amount 24,000 cubic yards are within the channel lines as approved, and the available width of channel has been reduced to 475 feet. To re-establish the full width of channel at this locality will require the removal of 27,400 cubic yards of material, which is estimated to cost $15,000.

On June 30, 1890, the main ship-channel is 23 feet deep at mean low water, 1,100 feet wide west of the Upper Middle, 750 feet wide at the Upper Middle, 1,000 feet wide at the Lower Middle, 625 feet wide at the Narrows, and 475 feet wide opposite the west end of Brewster Spit.

The following tributary channels have been improved by dredging and blasting:

1.—CHARLES RIVER.

This river enters the inner harbor near the navy yard at Charstown. Before improvement the natural channel had, as far up as Western Avenue Bridge, 4¾ miles from its mouth, 7 feet depth at mean low water, except in several places, covering about 1¼ miles in extent below Brookline Street Bridge, when the depth varied from 4½ to 7 feet.

From Western Avenue Bridge to Arsenal Street Bridge (2½ miles) there was a depth of 4 feet mean low water; thence to Market Street Bridge (¾ mile) 2¼ feet mean low water; and thence to the dam at the head of tide-water (1¾ miles) a depth varying from 0 to 9½ feet above mean low water. The mean rise or fall of the tides is 10 feet. A sketch showing the river was published in the Annual Report of the Chief of Engineers for 1884, page 512.

The project for the improvement of this river consists in straightening, widening, and deepening the natural channel, so that it should be from its mouth to Western Avenue Bridge 7 feet deep at mean low water and 200 feet wide; from Western Avenue Bridge to Market Street Bridge 6 feet deep at mean low water and 80 feet wide; thence to the dam at the head of tide-water 60 feet wide and 2 feet deep at mean low water.

The estimated cost of this improvement was originally $85,000. A revised estimate was submitted in 1881 of $125,000.

The total appropriations for this improvement to date have been $57,500. The total expenditures to June 30, 1888, were $57,378.99.

No operations were in progress during the fiscal year, and the condition of the improvement June 30, 1890, was as follows: The projected channel had been completed from the mouth of the river to Arsenal Street Bridge (7¼ miles); work was stopped at this point for the reason that the piers and draws of this bridge do not conform to the projected channel above it. In effecting this improvement 127,971 cubic yards were dredged during the years 1880–1884.

This improvement, even if the project were completed, is not regarded as an important benefit to commerce, for the conditions which exist on the lower reach of the river between Boston, Cambridge, and Charlestown make navigation of most any kind extremely expensive, slow, and difficult. Seven railroad and municipal bridges now exist on this lower part of the river, and an eighth is being built on the extension of West Chester Park street under authority of a State act. The funds available July 1, 1890, will be expended in surveys and examinations of the work.

2.—FORT POINT CHANNEL.

This channel is situated between the eastern shore of Boston proper on the one side and the reclaimed and improved flats of South Boston and South Boston on the other side. It connects the tidal basin of South Bay, which has an area of 250 acres, with Boston inner harbor, is fast becoming the center of the city's most extensive shipping trade, and is the most important branch of the main ship-channel. Fort Point Channel is 1¼ miles long. Before improvement the least depth at mean low water was 12 feet at its entrance and 17 feet above Congress Street Bridge. That part of it which it is proposed to improve is spanned by

bridges at Congress street, Mt. Washington avenue, and at an intermediate point. These bridges have conveniently located draw-openings, but the draw-piers of the railroad bridge must be strengthened or reconstructed before the improvement can be extended past them, and the width of the draw increased to that of the other bridges above and below it.

The project for this improvement was submitted January 27, 1885 (Annual Report, Chief of Engineers, 1885, page 545).

It proposed the excavation of a channel 175 feet wide and 23 feet deep at mean low water from the entrance to near Federal Street Bridge, a distance of 4,100 feet, and was estimated to cost $100,000; the railroad bridge to be reconstructed at the expense of the owners.

By the river and harbor act of August 5, 1886, the sum of $18,750 was appropriated for the improvement of that part of the channel lying below Congress Street Bridge.

The total expenditures to June 30, 1888, were $17,439.50.

No operations were in progress during the fiscal year, and the condition of the improvement on June 30, 1890, was as follows: The channel had been dredged as proposed from its entrance to Congress Street Bridge, a distance of 1,900 feet; 94,211 cubic yards were removed in effecting this improvement during the year 1887.

The funds available July 1, 1890, will be expended in examinations of the work. To complete the improvement as proposed to Federal Street Bridge will cost $60,000, and this sum could be expended to advantage during the fiscal year ending June 30, 1892, if the railroad draw shall have been properly reconstructed.

3.—HINGHAM HARBOR.

See separate report.

4.—NANTASKET BEACH CHANNEL.

This is a small channel along the east side of Hingham or Hull Basin. It leads to a wharf on the west side of the heel of Nantasket Beach, about 12 miles from Boston.

Before improvement it was approximately 100 feet wide and had a depth of at least 11 feet, except at the eastern end, 1,500 feet from the wharf, where the width was reduced to 40 to 50 feet and the depth to less than 8 feet. It was circuitous and obstructed by bowlders at the mouth of Weir River and by a ledge near the wharf.

The project adopted in 1880 was to widen and deepen the channel from the mouth of Weir River to the steam-boat wharf, so that it would be 100 feet wide and 9½ feet deep at mean low water; to remove a few bowlders at the mouth of Weir River, and to remove the ledge near the wharf.

The total appropriations and allotments for this work to June 30, 1889, were $11,750, all of which had been expended. The condition of the improvement June 30, 1889 was as follows: The projected channel had been completed by the removal of 41,922 cubic yards of material dredged and 54 cubic yards of ledge blasted during the years 1881–'83.

On September 30, 1889, $300 was allotted from the appropriation for Boston Harbor, for a survey of this channel. The survey showed that the channel where improved during the year 1881–'83 had deteriorated but slightly.

The steam-boat company using the channel have, however, found it

too narrow for their service, especially at the turn opposite "The Dolphin."

The survey showed that this turn could be materially improved by the removal of 9,000 cubic yards of material, at an estimated cost of $3,000. This amount was allotted from the general appropriation for Boston Harbor, on March 4, 1890.

On March 20, 1890, proposals were invited for the work by public advertisement and on April 21, 1890, the bids received were opened.

An abstract of them will be found in the annexed table. The lowest bid was accepted by the Chief of Engineers and on April 29, 1890, a contract was entered into with the Bay State Dredging Company.

Operations were commenced on May 19, 1890, and the work was satisfactorily completed June 6, 1890, by the removal of 9,025 cubic yards.

This part of the channel is now at least 250 feet wide, 9½ feet deep at mean low water.

The total expenditures to June 30, 1890, have been $14,067.80:

Tonnage of the channel in—

	Tons.
1874	390,226
1889	654,920

5.—CHANNEL BETWEEN NIX'S MATE AND LONG ISLAND.

This is a channel through the bar which extends from the north head of Long Island to Nix's Mate Shoal. Previous to the improvement there was 4½ feet depth of water on the bar at mean low tide.

The project for the improvement was adopted in 1883. It was to dredge a channel 200 feet wide, 12 feet deep at mean low water, and about 550 feet long. In 1887 it was recommended that the axis of the cut be shifted 30 degrees to the westward and that it be widened to 300 feet, 15 feet deep at mean low water. The original project was estimated to cost $9,000. The project of 1887 was estimated to cost $25,000. No specific appropriation has been made for this work.

The expenditures on it to June 30, 1888, from the appropriation for the improvement of Boston Harbor, were, for dredging, $9,551.76. No operations were in progress during the fiscal year, and the condition of the improvement on June 30, 1890, was as follows:

The original project had been completed by the removal of 19,899½ cubic yards of material during the year 1884.

The latest survey shows that the channel has retained its full width, and deepened throughout one foot approximately. The channel has been of the greatest service to the vessels and boats which ply to the wharves of the lower harbor, and has conferred a great benefit upon commerce by diminishing the number of passages of medium craft through the "Narrows," where the channel is narrow and overburdened and the currents transverse and irregular. These advantages will be largely increased so soon as the modified project of 1887 shall have been completed.

The estimated cost of this modified project is $25,000, all of which could be expended to advantage during the fiscal year ending June 30, 1892.

6.—BROAD SOUND.

An obstruction called Barrel Rock, lying on the north side of the Broad Sound Channel, was removed in 1869. It contained 116 cubic yards.

7.—HARBOR-LINES.

Examinations and surveys have been made for the Harbor-Line Board, and the preparation of plans for the Board's use has been continued during the year.

Recapitulation of amounts which could be expended to advantage during the fiscal year ending June 30, 1892.

Extension of Point Allerton sea-wall	$15,000
Repair of Great Brewster Island sea-wall	10,000
Sea-wall for Georges Island	35,000
Extension of Gallops Island sea-wall	12,000
Extension of Long Island sea-wall	3,000
Sea-walls for Governor's Island	80,000
Widening main ship-channel at "Upper Middle"	200,000
Completion of Fort Point Channel	60,000
Completion of channel between Nix's Mate and Long Island	25,000
Dredging at west end of Brewster Spit	15,000
Total	455,000

The several works completed and projected for the improvement of this harbor are located in the collection district of Boston and Charlestown, Mass. Boston is the port of entry.

The accompanying commercial statistics for the fiscal year ending June 30, 1890, have been furnished by the collector of customs at Boston, Mass.

Money statement.

July 1, 1889, amount available		$42,501.02
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$14,753.18	
July 1, 1890, outstanding liabilities	2,280.32	
		17,033.50
July 1, 1890, balance available		25,467.52
Amount appropriated by act of September 19, 1890		145,000.00
Amount available for fiscal year ending June 30, 1891		170,467.52
Amount (estimated) required for completion of existing project		395,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892		395,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for the removal of ledges from the harbor at Boston, Mass., opened December 7, 1890, by Lieut. Col. S. M. Mansfield, Corps of Engineers, U. S. Army.

No.	Name of bidder.	Price bid for removal of ledge per cubic yard measured in situ.	Total amount for removing 111 cubic yards.	Remarks.
1	George W. Townsend	$29.00	$3,219.00	Only bid received.

Contract awarded to Geo. W. Townsend, with the approval of the Chief of Engineers.

Abstract of proposals for dredging in the channel leading to Nantasket Beach, Boston Harbor, Massachusetts, opened April 21, 1890, by Lieut. Col. S. M. Mansfield, Corps of Engineers, U. S. Army.

No.	Names of bidders.	Price bid for dredging per cubic yard measured in scows.	Price bid for removal of bowlders per cubic yard weighing more than 3 tons each.	Total amount for dredging 9,000 cubic yards.	Remarks.
1	Bay State Dredging Company, A. B. Martin, proprietor.	$0.20	$8.00	$1,800.00	Lowest bid.
2	Eastern Dredging Company, by A. R. Wright, president.	.23	10.00	2,070.70	Informal.

Contract awarded to the Bay State Dredging Company with the approval of the Chief of Engineers.

COMMERCIAL STATISTICS.

Amount of revenue collected, $19,407,928.57.

Shipping.	Foreign.		Domestic.	
	Number.	Tonnage.	Number.	Tonnage.
Entrances	2,251	1,404,867		
Clearances	2,267	1,208,505		

Importations:	
Merchandise	$62,876,666
Coin and bullion	49,314
Exportations (domestic):	
Merchandise	70,364,955
Exportations (foreign):	
Merchandise	836,969

Tonnage for year ending June 30, 1867 (Chief of Engineers' Report, 1867, pages 466 and 476), 2,980 vessels, 731,930 tons.

Tonnage for year ending June 30, 1890, as by collector's statement, 2,251 vessels, 1,404,867 tons.

One new line of steamers between Boston and Liverpool, England, has been opened during the year, and in addition to the steamers which have been added to the lines running between this port and New York, Philadelphia, and Portland, a steamer has been placed on the route between Boston and Portsmouth, N. H.

B 11.

IMPROVEMENT OF HARBOR AT HINGHAM, MASSACHUSETTS.

Hingham Harbor is situated in the southern part of Hingham or Hull Basin, which comprises all that part of Boston Lower Harbor south of Nantasket Roads.

A chart of the harbor was published in the Annual Report of the Chief of Engineers for the year 1888, Part I, page 456.

The harbor covers an area of 1 square mile, and has extensive mud flats, bare at low tide.

The mean rise or fall of the tide is 9.4 feet.

The channel leading to Hingham south of Ragged and Sailor's islands was, before improvement, very narrow and crooked and obstructed by

sunken rocks and shoals. Its least width was 30 feet and least depth 4 feet at mean low water.

The object of its improvement is to widen and deepen the natural channel from deep water near the head of the harbor to the steam-boat wharf, a distance of 2,500 feet.

The original project for improvement was submitted December 23, 1874.

It provided for an improved channel on the east side of Sailor's Island, past the west side of Beacon to the Hingham Wharf, 100 feet wide and 8 feet deep at mean low water, at an estimated cost of $11,000.

This project was modified January 20, 1885, when it was proposed to deepen the improved channel to 10 feet at mean low water, and to remove a mid-channel ledge lying between Chandler's and Ragged islands, measuring 128 cubic yards, at a total cost of $18,700.

The total amount appropriated for this harbor to date is $21,000.

The total expenditures to June 30, 1889, were $16,142.68.

The condition of the improvement on June 30, 1889, was as follows: The original project had been completed; and the modified project of 1885 had been partly completed by dredging and blasting a channel 10 feet deep at mean low water, and 50 feet wide, through the ledge, which extends for 280 feet in length in the improved channel, about 1,600 feet northeast of the steam-boat wharf.

At the beginning of the fiscal year operations were in progress under a contract with Mr. G. W. Townsend to remove 200 cubic yards (more or less) of the ledge obstructing the improved channel, at $25 per cubic yard.

Operations had been commenced under this contract in May, 1889, and it was satisfactorily completed August, 1889, by the removal of 173 yards, of which 93 yards were removed during the year ending June 30, 1890.

The channel through the ledge is now 100 feet wide and 10 feet deep at mean low water.

No other operations were in progress during the year.

To complete the improvement will require an appropriation of $8,000, all of which could be expended to advantage during the fiscal year ending June 30, 1892.

The benefit to be expected by the completion of this improvement is a more convenient and safe navigation of the channel leading to the town wharves.

Hingham Harbor is in the collection district of Boston, Mass.

The nearest light-house is the Narrows Light on the main ship-channel in Boston Harbor, distant about 5 miles.

Commercial statistics included in Boston Harbor.

Money statement.

July 1, 1889, amount available	$702.32
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	697.31
July 1, 1890, balance available	5.01
Amount appropriated by act of September 19, 1890	5,000.00
Amount available for fiscal year year ending June 30, 1891	5,005.01
Amount (estimated) required for completion of existing project	3,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	3,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Tonnage of the harbor in—

1874	tons	273,090
1889	do	569,070

No new lines of transportation have been established.

B 12.

IMPROVEMENT OF HARBOR AT SCITUATE, MASSACHUSETTS.

Scituate Harbor is on the west shore of Massachusetts Bay, 14 miles from either Boston or Plymouth light-house, and just southwest of the direct sailing course of all ocean-going vessels entering Boston Harbor.

Before improvement the harbor had a low-water area of 57 acres approximately, more than 6 acres of which had a depth of at least 3 feet at mean low water. It was entirely open to the action of east winds, and the entrance was obstructed by many sunken bowlders. The depth on the bar was about 2½ feet at mean low water. The mean rise or fall of the tide is 9.8 feet.

A plan of the harbor, showing the proposed improvement, was published in the Annual Report of the Chief of Engineers for 1881, part 1, page 522.

The object of the improvement is to create a harbor of refuge for vessels bound to Boston that are too far south of their course to clear the dangerous ledges near Minot's light-house.

The project for the improvement adopted in 1881 is to build two rubble-stone breakwaters converging towards each other from opposite banks, and to dredge an anchorage basin with channels connecting with the sea and the town wharves.

The north breakwater from Cedar Point is to be 800 feet long, and the south breakwater, from the point of the "First Cliff," is to be 730 feet. Both breakwaters are to be 20 feet wide on top and 4 feet above mean high water except at their outer ends which are to be built 6 feet higher to serve as sites for entrance beacons.

The anchorage basin to be 30 acres in area, approximately. The entrance channel to be 2,700 feet in length and 300 feet average width. The estimated amount of dredging (including the entrance channel) was 500,000 cubic yards, to give a depth of 15 feet in the entrance channel; 12 to 15 feet between the breakwaters; 12 feet immediately in rear of the south breakwater, and 10 feet for the anchorage basin, at mean low water. The estimated cost of the breakwaters was $100,000, and of the dredging $190,000, a total of $290,000.

The total amount appropriated for this work to date is $52,500. The amount expended to June 30, 1889 was $47,546.08. The condition of the improvement June 30, 1889 was as follows:

The north breakwater was 720 feet long, of full width and height; the entrance channel was 100 feet wide, 1,600 feet long, and 5 feet deep at mean low water. The anchorage basin was 400 by 350 feet in area, 7 feet deep at mean low water. Nothing had been done on the south breakwater.

A portion of the beach between Cedar Point and the mainland was protected by a brush and stone bulkhead 450 feet long, in front of which was a stone apron 10 feet wide, 385 feet long. All known bowlders obstructing the entrance of the harbor were removed.

A contract was in force with Messrs. Boynton Bros. to dredge 9,000 cubic yards, more or less, scow measurement, from the channel leading from the basin to the town wharves.

Operations under this contract were commenced in August, 1889, and completed in September, 1889; 8,386 cubic yards of material were removed, and a channel was excavated from the basin to the town wharves 2,100 feet long, 25 feet wide, and 1 foot deep at mean low water.

Before improvement, in the upper half of this channel no low-water channel existed, and the flats averaged 2 feet above mean low water. Three feet increased draught can now be carried to the town wharves.

No other operations have been in progress during the fiscal year, and the condition of the beach protection, the entrance channel, the basin, and the north breakwater is essentially the same as at the date of the last report.

The amount required to complete the improvement is $237,500. Of this amount $50,000 could be profitably expended during the fiscal year ending June 30, 1892, as follows:

Build south breakwater, 400 feet long, 10,000 tons rubble, at $2.15	$21,500
Enlarge anchorage basin to 4 acres, 10 feet deep, and the channel to the town wharves to 150 feet wide, with the projected depth; 70,000 cubic yards of dredging, at 33 cents	23,100
Contingencies	5,400
Total	50,000

Scituate is in the collection district of Plymouth, Mass. The nearest port of entry is Plymouth, Mass.

The nearest light-house is Minot's Light, about 5 miles distant.

The accompanying commercial statistics have been furnished by the collector of customs at Plymouth, Mass.

Money statement.

July 1, 1889, amount available	$903.92
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	74.12
July 1, 1890, balance available	829.80
Amount appropriated by act of September 19, 1890	10,000.00
Amount available for fiscal year ending June 30, 1891	10,829.80
Amount (estimated) required for completion of existing project	227,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	50,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Amount of revenue collected, none.

Shipping.	Domestic.	
	No.	*Tons.*
Entrances	18	2,800
Clearances	18	2,800

Imported:	*Tons.*
Coal	1,800
Lumber	1,600

Schooners from 7 to 10 feet draught frequent the port.

No increase in the tonnage of the harbor is apparent since the improvement was commenced, and no new lines of water transportation have been established.

B 13.

IMPROVEMENT OF HARBOR AT PLYMOUTH, MASSACHUSETTS.

Plymouth Harbor is situated 30 miles south of Boston. Its outer anchorage, the "Cow Yard," is common to Plymouth, Kingston, and Duxbury, and is the only refuge for sea-going vessels from northeasterly gales when caught between Boston and Provincetown, a distance of about 75 miles, following the coast-line. The entrance to this outer anchorage is direct, unobstructed, and of ample width, and sufficiently deep for the wants of commerce. The anchorage is capacious and has good "holding ground," but the extensive tidal basins inside of it give rise to strong variable currents across it.

The inner or harbor proper is formed by Long Beach, a narrow, low sand-spit 3 miles long, which runs generally parallel to the mainland and about a mile from it.

The harbor contains 2,000 acres, almost all of which is dry at low tide. A few narrow, crooked, shallow channels traverse these flats. These channels join about the center of the harbor, opposite the town wharves, and form the main ship-channel, 150 feet wide, approximately, and 10 feet deep at mean low water, which runs directly behind the northern half of Long Beach to the outer anchorage.

The maintenance of this inner harbor and channel depends on the preservation of Long Beach.

Before improvement about 6 inches depth of water could be carried to the town wharves at low tide.

A chart of the harbor was published in the Annual Report of the Chief of Engineers for the year 1888, Part 1 page 460.

Previous to 1875 the project was a general one and had for its object the *preservation* only of Long Beach. From the nature of the work it can at no time be considered completed, and small annual appropriations are necessary to repair any damage done by storms. The various devices employed for this purpose are described in the Annual Report of the Chief of Engineers for 1877, all of which have been remarkably successful.

The project for the *improvement* of the harbor was first adopted in 1875. It provided for dredging a channel from the town wharves to the main ship-channel 2,286 feet long, 100 feet wide, and 6 feet deep at mean low water. This project was modified in 1877 so as to include the dredging of a basin 866 feet long, 150 feet wide, and 8 feet deep, directly in front of the town wharves.

In 1884 and 1885 it was proposed to deepen the improved channel and basin to 9 feet at mean low water, and to make the channel 150 feet wide.

The modified project of 1884 required the excavation of 81,000 cubic yards (scow measurement), and was originally estimated to cost $27,000. This estimate was revised in 1885, in accordance with the low prices then current for dredging, and the cost was then estimated to be $22,500.

From 1866 to date the amount appropriated for this improvement was $120,800, of which there had been expended to June 30, 1889—

For beach protection	$73,031.73
For dredging, etc	42,271.02
Total	115,302.75

The condition of the improvement on June 30, 1889, was as follows:

The improved channel was 115 feet in width, 9 feet in depth at mean low water; the basin was 800 feet in length, 9 feet in depth for 90 feet

of its width nearest the town wharves, and the remainder averaged 5 feet in depth; some repairs and extensions to the existing bulkheads on Long Beach were required.

At the beginning of the year a contract was in force with Mr. Augustus R. Wright to dredge 13,000 cubic yards, more or less, from the basin at 29⅞ cents per yard, scow measurement. Operations under this contract were commenced in October, 1889, and completed in November, 1889; 13,000 cubic yards were dredged from the basin, leaving it 800 feet long, with an average width of 150 feet, 9 feet deep at mean low water.

To complete the project will require, at present rates for dredging, an appropriation of $14,500.

A small sum should always be available for the harbor, to immediately repair any damage made by storms to Long Beach. These necessary repairs have in the last twenty years averaged $1,500.

During the fiscal year ending June 30, 1892, an appropriation of $17,500 could be expended to advantage for dredging, for necessary repairs and extensions of the present bulkheads on Long Beach, and for the repair of probable storm damages.

The prospective benefits to commerce are increased facilities and safety in navigating the improved channel.

Plymouth Harbor is located in the collection district of Plymouth, Mass., of which Plymouth is the port of entry.

The nearest light-houses are the Plymouth (Gurnet) lights, about 5 miles from Plymouth, and Duxbury Pier Light, about 2 miles distant.

The accompanying commercial statistics for the fiscal year ending June 30, 1890, have been furnished by the collector of customs at Plymouth, Mass.

Money statement.

July 1, 1889, amount available	$1,613.50
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	285.82
July 1, 1890, balance available	1,327.68
Amount appropriated by act of September 19, 1890	8,000.00
Amount available for fiscal year ending June 30, 1891	9,327.68
Amount (estimated) required for completion of existing project	9,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1892. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	9,500.00

COMMERCIAL STATISTICS.

Amount of revenue collected, $108,174.31.

Shipping.	Foreign.		Domestic.	
	No.	*Tons.*	*No.*	*Tons.*
Entrances	2	1,864	124	18,104
Clearances	10	1,443	120	17,148

Imported:	*Tons.*	Imported:	*Tons.*
Coal	23,500	Lumber	9,800
Iron	1,325	Miscellaneous	975

Vessels of all kinds from 8 to 14 feet draught frequent the harbor.

No increase in the tonnage of the harbor is apparent since the improvement was commenced, and no new lines of water transportation have been established.

B 14.

IMPROVEMENT OF HARBOR AT WELLFLEET, MASSACHUSETTS.

Wellfleet Harbor is situated on Cape Cod Bay, 12 miles southeast of Provincetown Harbor.

A chart of the harbor was published in the Annual Report of the Chief of Engineers for the year 1888, Part I, page 478.

The harbor consists of an outer anchorage south of Smalley's Bar, and an inner harbor north of the same bar.

The outer anchorage is sufficiently capacious, free from obstructions, and protected to meet the present demands of commerce, but the inner harbor, although capacious and perfectly protected, has no low-water navigable connection with the town wharves.

It is 4,200 feet from the 6-foot contour to the wharves, and not to exceed 6 inches draught can be carried to them at mean low water.

The original project for the improvement of this harbor was submitted November 3, 1871. It was based on the survey provided for in the river and harbor act of January 31, 1871.

It proposed to dredge two channels, each 150 feet wide and 4 feet deep at mean low water; one 2,060 feet long, to reach "Central" and "Commercial" wharves, and one 1,400 feet long, to reach "Mercantile" Wharf. It was also proposed to remove 204 cubic yards of sunken rocks. The cost of this project was estimated to be $30,000.

On November 28, 1887, a revised project was submitted. It was based on the survey provided for in the river and harbor act of August 5, 1886. It proposed to dredge a channel from the "Deep Hole" to the town wharves, 6 feet deep at mean low water, 100 feet wide, and 4,200 feet long, at an estimated cost of $24,000.

The total appropriations for this harbor to date have been $12,000.

By the river and harbor act of June, 1872	$5,000
By the river and harbor act of August 11, 1888	7,000
Total	12,000

The total amount expended to June 30, 1889, was $5,043.54, and the condition of the improvement on that date was as follows: "Mayo," "Bay," "Lobster," and "Lumpfish" rocks had been removed, and but 6 inches draught could be carried to the town wharves. A contract was in force with Mr. A. R. Wright to dredge 18,000 cubic yards at 34½ cents per yard, scow measurement.

Operations under this contract were commenced in August, 1889, and completed in October, 1889. Sixteen thousand nine hundred and eighty-four cubic yards of sand and mud were removed, and the channel now connecting the town wharves with the inner anchorage, the "Deep Hole" is 4,200 feet long, 4 feet deep at mean low water, and 25 feet wide.

Opposite the town wharves the channel was enlarged to 75 feet wide to facilitate the docking of vessels.

No other operations were in progress.

To complete the improvement will require at present prices for dredging an appropriation of $26,000, all of which could be expended to advantage during the fiscal year ending June 30, 1892.

The prospective benefits to commerce are increased facilities in navigating the inner harbor.

The accompanying commercial statistics for the fiscal year ending June 30, 1890, have been furnished by the collector of customs at Barnstable, Mass. The nearest light-house is Mayor's Beach Light.

Money statement.

July 1, 1889, amount available	$746.46
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	86.25
July 1, 1890, balance available	660.21
Amount appropriated by act of September 19, 1890	4,000.00
Amount available for fiscal year ending June 30, 1891	4,660.21
Amount (estimated) required for completion of existing project	22,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	22,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

The amount of revenue collected, $253.35.

Shipping.	Foreign.		Domestic.	
	No.	*Tons.*	*No.*	*Tons.*
Entrances			9	504
Clearances	1	74		

Imported:	*Tons.*	Imported:	*Tons.*
Coal	1,250	Merchandise	666
Lumber	300	Miscellaneous	300

Schooners from 6 to 12 feet draught frequent the harbor.

No increase in the tonnage of the harbor is apparent since the improvement commenced, and no new lines of water transportation have been established.

B 15.

IMPROVEMENT OF HARBOR AT PROVINCETOWN, MASSACHUSETTS.

Provincetown Harbor is situated at the extremity of Cape Cod, about 40 miles southeast from Boston Light.

It is one of the most valuable harbors of refuge on the Atlantic coast. The entire commerce of New England, and a very large local fishing interest, are directly benefited by its maintenance, which depends entirely on the preservation of the sandy beaches which inclose it.

Since 1826 the project has been a general one, and provides for the preservation of the harbor by building dikes, bulkheads, and sand-catches, and extensive planting of beach grass, to repair or prevent storm damages to the beaches. From the nature of the work it can at no time be considered completed.

A full history of the improvements will be found in the Annual Reports of the Chief of Engineers for the years 1876, 1879, and 1886. A special dike across House Point Island Flats, to be built contingently, was recommended in the Annual Report for 1886. A plan of the harbor was published in the Annual Report of the Chief of Engineers for 1886.

The total appropriations or allotments for this work up to date have been $146,478.44. The amount expended to June 30, 1889, was $141,043.27.

The condition of the improvement on June 30, 1889, was as follows

LONG POINT.

This long, narrow, low point forms the southeastern limit of the harbor. It had been protected on the east, or outside, by bulkheads, groins, and aprons, built of rubble-stone.

These bulkheads at the commencement of the year were being "leveled up" by the deposit of stone and "backed" with brush and stone to prevent the sea "making through" them, to the injury of the beach behind.

The necessary material for this work was being delivered under a contract with Mr. Charles H. Edwards, and the work was being done by hired labor. The contract was satisfactorily completed in September, 1889, by the delivery of 1,188 tons of stone and 150 cords of brush; and the work by hired labor was completed early in October, 1889.

The northerly end of Long Point is now fully protected from easterly storm action, but the northwestern part of the point, opposite the fog-signal station has for some time been abraded by storms, and to secure the light-house tract it will probably be necessary to extend the breakwater 250 feet to the west and south.

The northwest part of Long Point, between a point 2,000 feet west of Wood End Light and Abel Hill Dike is now the weakest portion of this vital part of the harbor. It is narrow and low, and in addition to damages caused by storms it is seriously injured by the portage of fishing-boats. One breach 60 feet long near Abel Hill Dike caused by this passage of boats, was closed with a plank bulkhead during January and February, 1890. A plank bulkhead to strengthen about one-third of this narrow part of the point was recommended and estimated for in the Annual Report of the Chief of Engineers for 1889, and should be built, at a cost of $6,000, so soon as funds are available.

Unless some change for the better shall occur in the conditions affecting this part of the point to strengthen it, it will soon need additional protection, or the harbor must be guarded on some more retired line.

ABEL HILL DIKE.

This dike was built to prevent the rush of water from Lancey's Harbor over House Point Island Flats into the main harbor.

The rapid wearing away of the southern sandspit that forms Lancey's Harbor had threatened to make a breach through the beach south of the dike. To guard against this, brush and wooden sand-catches had been built on the outer beach opposite the west end of the dike. They were all in good order.

HOUSE POINT ISLAND FLATS.

These flats remained essentially unaltered from the condition shown by the last survey, and, as stated in the Annual Report for 1887, it still appears unnecessary to commence the dike projected to be built across these flats. The most of the grass planted during the year 1888 had rooted and was growing at the date of this report.

BEACH POINT, HIGH HEAD DIKE, AND COVE SECTION.

These works were all in good order. During the fiscal year ending June 30, 1890, the only operations in progress were those at Long Point; and the several works of preservation were in good order at the date of this report, and serving the purpose for which they were built.

The nature of the works of preservation for this harbor requires a small sum to be always available for immediate repairs. Such necessary repairs have averaged $1,500 per annum, and, with $6,000 for the strengthening of Long Point, will make the amount necessary to be appropriated for this harbor $7,500.

The prospective benefit to commerce is the preservation of an important harbor of refuge.

Provincetown is a port of entry in the collection district of Barnstable, Mass. The nearest light-houses are Wood End and Long Point Lights.

The accompanying commercial statistics have been furnished by the deputy collector at the port of Provincetown, Mass.

Money statement.

July 1, 1889, amount available	$3,991.47
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	576.69
July 1, 1890, balance available	3,414.78
Amount appropriated by act of September 19, 1890	7,500.00
Amount available for fiscal year ending June 30, 1891	10,914.78
Amount that can be profitably expended in fiscal year ending June 30, 1892 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	7,500.00

COMMERCIAL STATISTICS.

The amount of revenue collected, $111.58.

Shipping.	Foreign.	
	No.	*Tons.*
Entrances	27	4,462
Clearances	20	1,924

Lumber exported	feet	24,844
Miscellaneous, imported	tons	1,000

Vessels of all sizes frequent this harbor for refuge.

Tonnage registered for year ending June 30, 1867 (page 466, Chief of Engineers' Report, 1867) 218 vessels, 16,229 tons.

Tonnage registered for year ending June 30, 1890, as given by collector of port, 122 vessels, 10,767 tons.

Since the improvement was started the Boston and Provincetown Steam-ship Company have commenced operations.

B 16.

REMOVAL OF SUNKEN VESSELS OR CRAFT ENDANGERING OR OBSTRUCTING NAVIGATION.

On July 6, 1889, report was made that a portion of the wreck of the schooner *J. E. Sanford* had drifted into the channel of Newburyport Harbor, Massachusetts, and was a dangerous obstruction. On July 12, 1889, the removal of this wreck was authorized and $1,000 allotted for the purpose. On July 20, 1889, public notice to the owners was issued, and proposals for the removal called for. No bids were received in response to this call.

On September 27, 1889, a circular letter was issued again asking for proposals for the removal of this wreck. An abstract of the bids received will be found in the annexed table. The lowest bid was accepted and Mr. G. W. Townsend at once commenced operations and completed the work during November, 1889. Final payment was not made until June, 1890, after the season would permit a careful examination of the site to be made by sweeping and boring.

On October 30, 1889, a report was made that the schooner *Anna A. Holton* had been sunk in Princetown Harbor, Massachusetts, and was a dangerous obstruction to navigation. On November 6, 1889, the removal of this wreck was authorized, and $3,000 was allotted for that purpose. On November 11, 1889, public notice to the owners was issued, and proposals invited for doing the work.

On December 12, 1889, the bids received were opened. An abstract of them will be found in the annexed table.

The acceptance of the lowest bid was recommended and authorized, and on December 19, 1889, a formal written contract was entered into, with the approval of the Chief of Engineers, with the Baker Wrecking Company, James Baker, manager. Operations under this contract were at once commenced and the wreck was completely removed early in January, 1890. No part of the material raised was of value, and it was deposited in deep water outside of the harbor.

Money statement.

Amount allotted July 12, 1889, $1,000; amount allotted November 6, 1889, $3,000		$4,000.00
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$2,007.84	
Deposited to credit of United States Treasurer	1,992.16	
		4,000.00

Abstract of proposals for the removal of a piece of the wreck of schooner John E. Sanford, from Newburyport Harbor, Massachusetts, opened October 8, 1889, by Lieut. Col. S. M. Mansfield, Corps of Engineers.

No.	Name of bidder.	Price bid for removal of wreck.	Price bid for furnishing plant per day.
*1	George W. Townsend	$500.00	$45.00
2	Baker Wrecking Company, J. E. Baker	700.00	75.00
3	Hiram W. Phillips	850.00	40.00
4	L. E. Lunt & Co	1,340.00	33.00

*Lowest bid.

Contract awarded to Mr. George W. Townsend with the approval of the Chief of Engineers.

Abstract of proposals for removal of wreck in Provincetown Harbor, Massachusetts, opened December 12, 1889, by Lieut. Col. S. M. Mansfield, Corps of Engineers.

No.	Name and residence of bidder.	Aggregate amount bid for removal of wreck.
*1	Baker Wrecking Company, James Baker, manager, Boston, Mass	$1,338
†2	George W. Townsend, Boston, Mass	2,994
†3	J. E. Thompson, North Truro, Mass	1,500
†4	John G. Whitcomb, Angus McKay, Thomas S. Taylor Provincetown, Mass	1,400

*Informal; lowest bid. †Informal.

Contract awarded to the Baker Wrecking Company with the approval of the Chief of Engineers.

B 17.

PRELIMINARY EXAMINATION OF CRANE AND WATERS RIVERS OF ESSEX BRANCH, MASSACHUSETTS.

UNITED STATES ENGINEER'S OFFICE,
Boston, Mass., November 1, 1888.

GENERAL: In compliance with instructions contained in your circular letter of August 28, 1888, I have the honor to submit this my report of the preliminary examination of Crane and Waters rivers of Essex Branch, provided for in the river and harbor act of August 11, 1888.

The Essex Branch is the central of the three rivers which unite to form that arm of the sea which is locally known as Beverly Harbor, Massachusetts. About 3 miles west of the Eastern Railroad bridge at Beverly the Essex divides into three branches, called, Porters, Waters, and Crane, respectively, from east to west. Upon or near these branches are situated Porters Corners, Danversport, East Danvers, and Danvers Plains, small manufacturing towns, with an aggregate population of 5,000 approximately. The main commerce of the entire river system centers at Danversport, where there are many wharves, over which coal, lumber, grain, and heavy articles required in the trades are handled.

It is stated that 25,000 tons of coal, 2,000,000 to 3,000,000 feet of lumber, and several thousand tons of general merchandise, carried in one hundred vessels, were received at Danversport during the past year. By comparison with the tonnage of twenty-five years ago, when there was a considerable trade with the West Indies, the commerce of to-day is much reduced, yet it is estimated that the industries now represented at the above places are valued at $4,000,000.

The draws of the bridges at Beverly afford 13 feet mean low water. For 1½ miles westward the channel is 150 to 200 feet wide and 15 feet deep mean low water, but just below the mouth of Crane River, the first tributary from the southward, the depth is reduced to 8 feet mean low water, and this depth is maintained with little variation in a narrow channel of scarcely 50 feet width to Marion's Wharf, near Danversport.

Crane River is dry at low water, and has only two or three wharves. Waters River, locally known as Middle River, has at average low stage about 2 feet depth to the town wharves. No hydrographic chart of the

river has ever been made; but I am informed by a pilot who has known the river intimately for twenty-five years that Marion's Wharf can be reached at all stages of the tide by vessels drawing not exceeding 8 feet. The range of tides is 10 feet and over. It is stated that no rocks, bowlders, or sunken ledges exist anywhere in the channel. I have made a personal examination of the river at Beverly and above the junction of the three rivers, and am of the opinion that Waters River (Middle River) from its mouth to Danversport, a distance of less than one-half mile, is "worthy of improvement," if the improvement can be made within reasonable limits. I therefore recommend an allotment of $350 for making a survey of Waters River, from Danversport to the junction of Essex River, for the purpose of preparing a project for opening a channel from Beverly to Danversport 100 to 150 feet wide and 8 feet deep, mean low water.

Very respectfully, your obedient servant,

G. L. GILLESPIE,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

NOTE.—From information received subsequent to the date of this report it has been ascertained that the river referred to above as Waters River is in reality Crane River, and survey of the latter has accordingly been authorized.

SURVEY OF CRANE AND WATERS RIVERS OF ESSEX BRANCH, MASSACHUSETTS.

UNITED STATES ENGINEER OFFICE,
Boston, Mass., December 2, 1889.

GENERAL: I have the honor to forward herewith a report of Mr. T. T. Hunter Harwood, assistant engineer, on the survey of Crane and Waters rivers, of Essex Branch, Massachusetts, made in compliance with Department instructions of April 1, 1889, and August 7, 1889, to comply with the provisions of the river and harbor act of August 11, 1888.

A tracing* of the survey is also submitted, on which is indicated the proposed projects for improvement.

* * * * * * *

The improvement proposed for Waters River is to enlarge the present low-water channel of the river so that it will be 100 feet wide and 8 feet deep at mean low water, from deep water of Essex Branch to the wharves at the head of navigation, a distance of 2,600 feet, approximately. The excavation of this channel will require the removal of 40,000 cubic yards of material, at an estimated cost as follows:

Dredging 40,000 cubic yards, at 30 cents	$12,000
Contingencies	2,000
Total	14,000

The improvement proposed for Crane River is to enlarge the present low-water channel, so that it will be 100 feet wide and 8 feet deep at mean low water, from deep water of Essex Branch to the wharves at Danversport, Mass., an approximate distance of 2,850 feet; and also

* Omitted; printed in House Ex. Doc. No. 23, Fifty-first Congress, first session.

to dredge a small shoal spot in Essex Branch, just south of the mouth of Crane River, so that 8 feet at mean low water can be carried over it, in a channel 100 feet wide.

To effect this improvement will require the removal of 65,500 cubic yards of material, at an estimated cost as follows:

Dredging 65,000 cubic yards, at 30 cents	$19,500
Blasting 500 cubic yards, at $15	7,500
Contingencies	3,000
Total	30,000

I respectfully invite attention to the accompanying report of Mr. T. T. Hunter Harwood, assistant engineer, for the details of the survey and a general description of the rivers and their approaches.

Crane and Waters rivers, Massachusetts, are in the collection district of Salem, Mass., of which Salem is the port of entry; the nearest light-house is at Hospital Point, Beverly Harbor, Massachusetts.

Very respectfully, your obedient servant,

S. M. MANSFIELD,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. T. T. HUNTER HARWOOD, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Boston, Mass., October 26, 1889.

COLONEL: I have the honor to submit the following report on the survey of "Crane and Waters rivers, of Essex Branch, Massachusetts," made in September, 1889, in pursuance of your instructions, together with a map of the survey drawn to a scale of 1:2500.

TOPOGRAPHY.

A base line 3,944.83 feet long was measured along the Boston and Maine Railroad track, which crosses Essex Branch at its mouth. Twenty-five triangulation stations were located and occupied, the most important ones being repeated not less than three times.

From these points a system of ranges was arranged on which the soundings were taken. The high-water and low-water lines are from this survey.

HYDROGRAPHY.

A close survey was made of Crane and Waters rivers, and an examination made of Essex Branch to determine the location of the channel known to exist. Sixty-three ranges were established, on which 3,040 soundings were taken, 422 of which were intersected with a transit from suitable stations. The soundings are expressed in feet and tenths and refer to mean low water. The tide-staff was set from the bench-mark for Beverly Harbor, on the Salem and Beverly highway bridge, at the mouth of Essex Branch. The mean rise or fall of tide is assumed to be the same as in Beverly Harbor, 9.2 feet.

DESCRIPTION OF CHANNEL AS DEVELOPED BY SURVEY.

Essex Branch is about 2 miles in length, and is formed by the confluence of two small rivers, known as Porter's and Crane, the first-named being the more northerly. About 1,700 feet below the junction of these two rivers, Waters River empties into it from the west. It flows in a generally easterly course and empties into Beverly Harbor. At its mouth it is crossed by the Salem and Beverly highway bridge, and the Boston and Maine (eastern division) railroad bridge. The draw in the former is 33 feet in the clear, in the latter 40 feet. The least depth of water in the draws is 11.9 feet. The railroad draw is placed in entire disregard to the general direction of the main channel of the river.

Passing through the bridges a tortuous 12-foot channel extends for a distance of about 7,000 feet with a least width of 150 feet and there terminates.

Here the 8-foot channel, which thus far has maintained a least width of 280 feet, suddenly narrows to 150 feet and extends for about 2,000 feet farther with this width, or until opposite the mouth of Waters River, a short distance above which it ends. The 6-foot channel, which to this point has been at least 175 feet wide, gradually narrows to 75 feet opposite the mouth of Crane River, and continues past the mouth up to Merriam's coal wharf in Porter's River, the natural continuation of Essex Branch, where the survey ends.

CRANE RIVER.

At the mouth of Crane River a bar exists with a greatest depth of 1.8 feet at low water, passing which a low-water channel of about 60 feet average width and a greatest continuous depth of 1.7 feet extends for a distance of 2,400 feet into a shallow low-water basin opposite the wharves of Danversport. Here the river is closed to navigation by a dam, which furnishes power for a water-mill.

Borings were made at 13 stations in the river to determine the character of the bottom, the results being recorded in the annexed table of borings. In addition to these 59 borings were made in examination of a small ledge found at boring station No. 5. The approximate size and shape of this ledge are indicated on the map, and a plot of the borings drawn to a scale of 1:1000 is submitted herewith.

WATERS RIVER.

A low-water channel extends for 1,200 feet up this river with an average width of 70 feet, widening at its upper end into a shallow basin bounded by wharves.

The river is here closed to navigation by a dam, which stores power for water-mills. The greatest continuous depth in the channel is 4.0 feet.

Borings made at five stations in the river determined the bottom mainly to consist of soft black mud to the depths attained, which are indicated in the annexed table of borings.

Very respectfully, your obedient servant,

T. T. HUNTER HARWOOD,
Assistant Engineer.

Lieut. Col. S. M. MANSFIELD,
Corps of Engineers, U. S. A.

Borings in Crane River.

No.	Sounding.	Material.	To a depth of—	Then through—	To a total depth of—
1	2.2	Soft mud	4.9	Hard mud and clay	4.9
2	1.4	Soft sand and mud	5.6	Hardpan	5.6
3	3.7	....do			10.7
4	4.7	Soft mud	10.2	Clay	11.7
5	2.4	Ledge			2.4
6	0.1	Soft mud	5.6	Hard clay	7.1
7	1.7	....do	6.7	Hard mud and sand	8.7
8	2.3	Soft sand and mud	8.9	Hard clay	8.9
9	1.8	....do	9.0	Hard sand and clay	9.8
10	1.8	....do	6.3	....do	8.8
11	3.5	Gravel, sand, and mud	5.0	Hard clay	5.7
12	−0.4	Sand and mud	4.6	Hard crust, sand, and clay	5.6
13	2.7	....do	6.5	Hard clay	8.2

Borings in Waters River.

No.	Sounding.	Material.	To a depth of—	Then through—	To a total depth of—
1	4.0	Soft mud			12.2
2	4.6	Sand and mud			10.9
3	1.7	Soft mud and clay			10.2
4	1.3	Gravel	3.3	Sandy clay	7.2
5	3.7	Soft sand and mud			10.5

NOTE.—Borings are expressed in feet and tenths below mean low water. Boring stations are indicated on the map by circles and figures. Thus; ⊙ 13.

B 18.

PRELIMINARY EXAMINATION OF WEYMOUTH (FORE) RIVER, MASSACHUSETTS.

UNITED STATES ENGINEER OFFICE,
Boston, Mass., October 27, 1888.

GENERAL: In compliance with instructions contained in your letter of August 28, 1888, I have the honor to submit the following report of a preliminary examination of Weymouth (Fore) River, Massachusetts, provided for in the river and harbor act of August 11, 1888.

Weymouth (Fore) River, tributary to Hingham Bay, Boston Harbor, on the southwest, is the most important water-course on the south coast of Massachusetts Bay, and furnishes a valuable water-way, 18 to 20 feet deep at mean low water, from Hingham Bay to Quincy Point, an approximate distance of 4½ miles, beyond which a further distance of 2½ miles to Weymouth Landing and East Braintree, the head of navigation, the available depth varies from 5 to 14 feet, mean low water. It traverses a manufacturing district containing a population of 50,000 people, which is rapidly increasing.

It has on its banks wharf facilities consisting of 3,000 linear feet of granite wall, built at a cost of 70,000, over which were handled during the year 1887 41,200 tons of coal, 30,000 tons of granite, 8,000,000 feet of lumber, 600,000 bricks, besides large quantities of cement and iron pipe. These articles had a total valuation of $785,000, on which were paid $148,000 freight charges.

The inclosed petition, signed by reputable business men in the community, states that if the river had afforded 16 feet at high water to East Braintree $14,800 would have been saved in freight charges during the year 1887.

Several new manufacturing industries have been built lately upon the river, which have added more than one hundred to the number of operatives.

During the past ten years $11,700 have been expended by private enterprise for dredging in and adjacent to the channel between East Braintree and Quincy Point.

The river is obstructed, it is alleged, by shoals and rocks at various points, all of which lie principally in the section of 2 miles long which extends from Quincy Point to East Braintree. There is also one shoal one-fourth of a mile below Quincy Point, in the bend opposite Germantown (Coast Survey chart, 1878).

The range of tides is 10 feet approximately.

The river is "worthy of improvement," and I have the honor to recommend an allotment of $600 to provide for a survey of the channel from the shoal below Quincy Point westward to East Braintree, in sufficient detail to enable me to prepare a project for improvement.

The river has been examined by me personally, and it is estimated, in advance of the survey, that a satisfactory improvement can be made at a cost not exceeding $25,000.

Very respectfully, your obedient servant,

G. L. GILLESPIE,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

SURVEY OF WEYMOUTH (FORE) RIVER, MASSACHUSETTS.

UNITED STATES ENGINEER OFFICE,
Boston, Mass., December 2, 1889.

GENERAL: In compliance with instructions contained in Department letter of April 1, 1889, I have the honor to transmit herewith a report of Mr. Sophus Haagensen, assistant engineer, on the survey of Weymouth River, Massachusetts, made to comply with the provisions of the river and harbor act of August 11, 1888.

A tracing* of the survey is also transmitted upon which is indicated the proposed project for improvement.

The report of the preliminary examination of this river is dated October 27, 1888, and attention is respectfully invited to it for a general description of the river, and the reasons for making the survey.

The improvement proposed is to enlarge the natural channel of the river by dredging, so that 6 feet depth at mean low water can be carried to the head of navigation.

The improved channel is designed 100 feet wide to near the wharves at Weymouth Landing, thence to Braintree Bridge, 80 feet wide, and above Braintree Bridge, 50 feet wide, with increased width at each turn to facilitate the movement of vessels.

The total length of channel to be improved is 7,000 feet approximately, and its excavation will require the removal of 96,600 cubic yards of material at an estimated cost as follows:

Dredging 92,000 cubic yards mud, at 35 cents	$32,200
Dredging 4,600 cubic yards hardpan, at 75 cents	3,450
Contingencies	4,350
Total	40,000

I respectfully invite attention to the accompanying report of Mr. Sophus Haagensen, assistant engineer, for the details of the survey and the general description of the river and its approaches.

Weymouth River, Massachusetts, is in the collection district of Boston, Mass., of which Boston is the port of entry. The nearest light-house is situated on Long Island, Boston Harbor, Massachusetts.

Very respectfully, your obedient servant,

S. M. MANSFIELD,
Lieut. Col. of Engineers.

Brig. Gen. THOMAL L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. SOPHUS HAAGENSEN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Boston, Mass., July 29, 1889.

COLONEL: I have the honor to report upon the survey of Weymouth (Fore) River, Massachusetts, made in May and June, 1889, in pursuance of your instructions; also to submit two maps, one a general map of the survey, drawn to a scale 1:3000, and one a special survey of Quag Rocks, drawn to a scale 1:600.

TOPOGRAPHY.

Two base lines were measured, one A, B, C, opposite Germantown, 2,243.48 feet long, and one on the track of the Old Colony Railroad, 1,950 feet long. The triangulation extending from and connecting these bases was made on the plane table, as

* Omitted; printed in House Ex. Doc. No. 26, Fifty-first Congress, first session.

was also the location of shore-lines, buildings, and objects used for ranges in the hydrographic work. Of the main stations in the survey fifteen were permanently marked by 3 inches by 3 inches posts sunk 3 feet into the ground.

HYDROGRAPHY.

The area covered by the survey extends from "Hunt's Hill Point," opposite Germantown, to the head of navigation, viz, the dam on the "Monatiquot River" and the Old Colony Railroad Bridge across "Smelt Brook." It contains about 450 acres within the extreme high-water lines, and of these about 175 acres were covered by our soundings. One hundred and twenty-one lines were run, aggregating in length 12 miles, upon which 2,875 soundings were taken.

All the soundings except those in the channel from Quincy Bridge to 5,000 feet above this point, and also in the upper part of the river between Braintree Bridge and the dam, were precisely located by intersection from shore stations; the others were run by time on lines between shore stations.

The soundings are expressed in feet and tenths and refer to mean low water; those appearing on the map in feet and quarters are copied from the United States Coast Survey manuscript map of 1869, enlarged from scale 1:10000.

TIDES.

The tides are the same as for Boston Lower Harbor, viz:

	Feet.
Mean rise or fall of tide	9.4
Extreme low water observed	2.5
Extreme high water observed	12.2

The plane of reference was transferred from the lower harbor to the river by simultaneous observations of three high-water slacks on the normal staff at Fort Warren, and a tide-staff established at Quincy Bridge; thence by water-level again to the staff at Braintree Bridge, where a permanent bench-mark was established.

It is a one-half inch drill hole 2 inches deep on the southeast corner of the granite draw-pier of Braintree Bridge, and is in grade 11.9 feet above mean low water. Besides this mark four spikes were driven, two in each of the piles to which the tide-staffs were attached, in grade 10 feet above mean low water.

DESCRIPTION OF THE CHANNEL AS DEVELOPED BY THE SURVEY.

The initial point of the survey between Hunt's Hill Point and Germantown is 7 miles distant by water from the entrance to Boston Harbor at Boston light. Passing through light-house channel and Nantasket roads, through Nantasket (or Hull) Gut, between Peddock's Island and Hough's Neck on the west, and Sheep Island, Grape Island, and Weymouth on the east, there is a continuous 18-foot channel. This ends at the southerly point of Germantown, where a bar runs across to Ferry Point; 14 feet can be carried across this bar past the junction of Weymouth (Fore) River with "Town River" (from Quincy), at Quincy Point, where the 18-foot channel again commences 250 feet below Quincy Bridge. Above Quincy Bridge there is a straight reach running southwards with the 18-foot and 12-foot channels extending, respectively, 1,850 feet and 2,200 feet above the bridge; at this latter point the channel turns to the east and gradually decreases in width from 350 feet to 100 feet, and in depth from 12 to 8 feet, at the entrance to the Upper River, a mile above Quincy Bridge.

For 1,500 feet further there is yet a narrow 6-foot channel averaging 50 feet in width, until this closes by the "Quag Rocks." Although there is a thread of water 4 feet in depth over these rocks, there is not a practicable channel over 3 feet deep.

Above Quag Rocks there are pools with 6 feet of water, but no navigable channel with more than 4 feet at mean low water. Four thousand three hundred feet further the 4-foot channel ceases at the junction of Monatiquot River and Smelt Brook, where the bar is passable with 3 feet. Five hundred feet above this bar is Braintree Bridge. Above this bridge to the dam, a distance of 1,400 feet, the pool is 5 feet deep, but there is only a continuous 2-foot channel at present. In Smelt Brook the channel very soon loses its depth from 4 feet opposite J. B. Rhine's lumber-yard to 2 feet at the Old Colony Railroad Bridge, 800 feet above. For the last 1½ miles the axis of the channel is a series of curves, exceedingly difficult to navigate. Thus opposite the base-line on the Old Colony Railroad track there is an S curve, each branch with 250 feet radius through 90 degrees.

BRIDGES AND DRAWS.

Quincy Bridge.—Two and one-half miles below the head of navigation is the first bridge on this river, Quincy Bridge. It connects Quincy Point (town of Quincy) with Ferry Point, Weymouth. It is a pile bridge 850 feet long between the abut-

ments. The draw, which is double vertically folding, has a width of 36.7 feet in clear. Its location is not in the deepest part of the channel, where the depth is 19 feet, but 150 feet west thereof, where the depth is only 12 feet. The draw-pier, extending 125 feet above and below the bridge, does not follow the 12-foot contour; off the southerly end of the draw-pier in the axis of the draw is only 9 feet of water, so that vessels passing up-river must haul off eastwardly from the pier after passing the draw.

Braintree Bridge is over 1,400 feet below the dam on the Monatiquot River; the draw has a clear opening of 35 feet in width and is located properly in the deepest water; the draw-pier also conforms to the direction of the channel.

Old Colony Railroad Bridge, over Smelt Brook, is at the head of navigation and has no draw.

BORINGS.

Beside a number of random borings with an iron rod, thirty-five were located and registered. Their positions are shown on the plan by red circles, and the character of the bottom penetrated is stated in the annexed table.

The main fact developed by the borings is that the "Quag Rocks" are not ledges, as was supposed, but a bed of bowlders and cobble imbedded in clay, dipping gradually from the west to the east side of the river (see borings 1 to 8 and 33 to 35 inclusive). Above and below Quag Rocks the river bottom is mud and sand in varying thicknesses overlying the hardpan, consisting of gravel and clay.

Very respectfully, your obedient servant,

SOPHUS HAAGENSEN,
Assistant Engineer.

Lieut. Col. S. M. MANSFIELD,
Corps of Engineers, U. S. A.

B 19.

PRELIMINARY EXAMINATION OF BEVERLY HARBOR, MASSACHUSETTS.

UNITED STATES ENGINEERS OFFICE,
Boston, Mass., November 1, 1888.

GENERAL: In compliance with instructions contained in your circular letter of August 28, 1888, I have the honor to submit this my report of the preliminary examination of Beverly Harbor, provided for in the river and harbor act of August 11, 1888.

Beverly Harbor is a small harbor at the western end of Salem Bay, Massachusetts, and immediately adjacent to Salem Harbor on the south, from which it is separated by Salem Neck. It is formed by the confluence of the three branches of a tidal inlet, called respectively North River, Essex Branch, and Beverly Creek. It is a basin of irregular shape, measuring three-eighths of a mile in diameter, and is bounded on the west, south, and east sides by flats and shoals, with occasional rocks. It is crossed at its western extremity by two draw-bridges, located a short distance apart—the Salem highway bridge and the bridge of the Eastern Railroad. These bridges have draws 32 feet wide, in which the depth is 13 feet, mean low water, approximately. All vessels going into either of the three branches before mentioned must pass through Beverly Harbor, where the channel is 200 to 600 feet wide, and 15 to 20 feet deep, mean low water.

The entrance to the harbor is made difficult by reason of the shoals which project southward from Tuck's Point on the north shore, and northward from Salem Neck at Old Hospital Point, on the south shore. The three groups of rocks on the borders of the anchorage are conspicuously marked by stone beacons.

During the fiscal year ending June 30, 1888, 199 vessels discharged cargoes at Beverly, with an aggregate tonnage of 22,702 tons; 681 ves-

sels passed through the draws of the two bridges, 80 of which took 20,000 tons of coal and 2,000,000 feet of lumber to Danversport.

While Lobster and Ram's Horn rocks tend to restrict the dimensions of the harbor, yet they are well marked by stone beacons and leave between them plenty of safe anchorage for all the vessels which use the harbor. There is also plenty of water in the entrance channel, and the sailing course is well marked by buoys. The only fault, it is believed, that can be found with the channel is, that it is alleged to have a small obstructing rock opposite's Tuck's Point, and that it is circuitous in its passage through the shoals which lie at the entrance, whose formation is due to the action of the easterly storm waves, as they drive in from the sea without breaking, after passing through the strait between Baker's and Great Misery islands. It is probable that if the channel were straightened it would soon fill up.

The existing depth of water in the harbor and in the entrance channel is sufficient for the commerce of the harbor and of its tributary streams, if it be made available by the removal of the obstructing rock off Tuck's Point.

I am therefore of the opinion that the harbor is "worthy of improvement" to the extent of the removal of the obstructing rock.

The last surveys of the whole harbor were made in 1850–1869, but it is not known at what time Beverly Harbor proper was surveyed or re-examined.

It is possible that the depths given upon the chart, corrected to 1888, are not the true depths. I therefore recommend an allotment of $500 for making a survey of the harbor from the anchorage through the entrance channel to the outer bar, to develop the present condition of the channel, and to enable me to form a project for the improvement actually demanded by commerce for its protection and convenience.

Any general improvement of the entrance by dredging the channel so that its several reaches shall be absolutely straight, 300 feet wide, and 18 to 20 feet deep, mean low water, will cost, it is estimated, from $40,000 to $50,000, and when done will be of uncertain maintenance.

Very respectfully, your obedient servant,

G. L. GILLESPIE,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

SURVEY OF BEVERLY HARBOR, MASSACHUSETTS.

UNITED STATES ENGINEER OFFICE,
Boston, Mass., December 2, 1889.

GENERAL: In compliance with instructions contained in Department letter of April 1, 1889, I have the honor to forward herewith a report of Mr. T. T. Hunter Harwood, assistant engineer, on the survey of Beverly Harbor, Massachusetts, made to comply with the provisions of the river and harbor act of August 11, 1888.

A tracing* of the survey is also submitted.

The report of the preliminary examination of this harbor is dated November 1, 1888, and attention is respectfully invited to it for a general description of the harbor and the reasons for making the survey.

---

* Omitted; printed in House Ex. Doc. No. 27, Fifty-first Congress, first session.

This preliminary report states that "the existing depth of water in the harbor and in the entrance channel is sufficient for the commerce of the harbor and of its tributary streams, if it be made available by the removal of the obstructing rock off Tuck's Point," and "that the harbor is worthy of improvement to the extent of the removal of the obstructing rock."

By the report of Mr. T. T. Hunter Harwood, assistant engineer, to which I respectfully invite attention for the details of the survey and a general description of the harbor, it will be seen that a careful search was made for the rock supposed to obstruct the entrance off Tuck's Point without success, and I therefore submit no project for the improvement of this harbor, as I am of the opinion that the present condition of the harbor and its approaches is sufficient for its commerce.

Beverly Harbor, Massachusetts, is in the collection district of Salem, Mass., of which Salem is the port of entry; the nearest light-house is on Hospital Point, Beverly Harbor, Massachusetts.

Very respectfully, your obedient servant,

S. M. MANSFIELD,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. T. T. HUNTER HARWOOD, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Boston, Mass., October 3, 1889.

COLONEL: I have the honor to submit the following report upon the survey of Beverly Harbor, Massachusetts, made in August, 1889, in pursuance of your instructions; also to submit a map of the survey, drawn to a scale of 1:2500.

TOPOGRAPHY.

A base line 1,700.24 feet long was measured along the highway bridge between Salem and Beverly. Fourteen triangulation stations were located and occupied, the angles being all repeated, the most important ones five times. From these stations radiating fans of ranges were established and the soundings cut in. Two of these points, Hospital Point Light and Fort Pickering Light, are United States Coast Survey points, and from these the true meridian and projection were obtained. The outer wharf corners of Beverly Harbor and the highway bridge are from this survey; the high-water line and the low-water line, where not developed by soundings, are taken from the United States Coast Survey manuscript map of 1851, enlarged from a scale of 1:10000 to the scale of the accompanying map.

HYDROGRAPHY.

The area covered by our soundings embraces the entire harbor, from a line drawn from Hospital Point on the north to Juniper Point on the south of the entrance west to the highway bridge at the head of the harbor.

Eighty-seven ranges, aggregating 24 miles in length, were established, on which 6,217 soundings were taken, 1,127 of which were intersected with a transit from suitable triangulation stations on shore.

The bench-mark was transferred by high-water level from Derby Wharf, Salem, a distance of 3 miles, and checked by simultaneous observations at Beverly and Salem.

DESCRIPTION OF CHANNEL AS DEVELOPED BY THE SURVEY.

The approach to Beverly Harbor is from Massachusetts Bay through the main Ship Channel leading to Salem Harbor, continuing on a general westerly course, after *clearing the* ledges lying west of Baker's Island, until the entrance of the harbor is

reached. The nearest light-house is Hospital Point Light, on the north side of the entrance. The entrance to the harbor is about 3,500 feet wide between Woodbury Point on the north and Salem Neck on the south, but the channel is narrowed to 1,500 feet between the 18-foot curves of these points by extensive shoal ground off Woodbury Point, and is further obstructed by a small shoal off Salem Neck, leaving a clear 18-foot channel 1,000 feet wide between these shoals.

From this point the channel in the outer harbor runs northwest a distance of 1,200 feet to a large mid-channel shoal, which narrows it to 300 feet, and passing north of this shoal it carries this width on a curve of about 2,500 feet radius around to south until directly west of the first beacon at the extremity of a bar running off from Salem Neck. Up to this point the 12-foot channel has gradually narrowed from about 1,800 feet to 450 feet. Continuing south from this point the channel is narrowed in about 500 feet distance to 150 feet in the 18-foot and 250 feet in the 12-foot curves by extensive shoal ground extending southeast from Tuck's Point, and maintains these widths on a curve of about 1,500 feet radius around this shoal until the second beacon, situated on Ram's Horn Rocks, in the southern part of the harbor, is passed.

Here the 12-foot curve widens, forming the anchorage-ground of the inner harbor, a basin of about 25 acres extent. This basin is obstructed by a large shoal extending from the shoal ground off Tuck's Point with an average depth of 16 feet, the shoalest sounding taken being 10.5 feet, near its southern extremity.

The 18-foot channel passes west through the anchorage-basin to the south of this shoal, maintaining a least width of 150 feet until Tuck's Point bears north, where it turns abruptly to the north, running between Lobster Rocks beacon and Tuck's Point, and then westerly with increased width along the front of the wharves of Beverly, and terminates 500 feet from the draw-bridge between Salem and Beverly. From this point the depth gradually shoals up to 12 feet in the draw, which is 33 feet wide in the clear.

Borings made at the points indicated on the map by circles and figures determined the bottom to be mainly soft mud and sand. In a few places ledge was found, as is shown by the results recorded in the table of borings annexed.

A rock being reported in the channel near boring No. 10, off Tuck's Point, a careful search was made for it, but close sounding and sweeping of the bottom, with the aid of the local pilot, failed to discover any other rock than the ledge, as indicated by this boring, underlying the shoal which narrows the channel at this point.

Very respectfully, your obedient servant,

T. T. HUNTER HARWOOD,
Assistant Engineer.

Lieut. Col. S. M. MANSFIELD,
Corps of Engineers, U. S. A.

Table of borings.

No.	Sounding.	Material.	To a depth of—	Then through—	To a total depth of—
1	12.5	Sand and mud	15.5	Hard crust	17.3
2	12.1	Soft mud	15.6	....do	16.6
3	11.9	Mud	12.5	Ledge	12.5
4	15.7	Soft sand and mud	18.7	Hard crust	18.7
5	15.7	....do			19.7
6	15.0	Gravel	15.5	Ledge	15.3
7	14.0	....do	14.4	....do	14.4
8	11.5	Soft mud and gravel			19.0
9	14.8	Hard pan			18.8
10	12.6	Gravel	13.6	Ledge	13.6
11	11.6	Soft sand and mud	17.6	Hard sand	20.6
12	16.0	....do	16.0	....do	18.0
14	16.0	Sand	17.0	Ledge	17.0
15	10.7	Soft mud			13.7
16	10.5	....do			17.0

NOTE.—Borings are expressed in feet and tenths below mean low water. Boring stations are indicated on the map by circles and figures, thus: ⊙16.

B 20.

PRELIMINARY EXAMINATION OF SALEM HARBOR, INCLUDING SOUTH RIVER, MASSACHUSETTS.

UNITED STATES ENGINEER OFFICE,
Boston, Mass., November 1, 1888.

GENERAL: In compliance with instructions contained in your circular letter of August 28, 1888, I have the honor to submit this my report of the preliminary examination of Salem Harbor, including South River, provided for in the river and harbor act of August 11, 1888.

Salem Harbor is at the western end of a deep indentation in the shores of Massachusetts Bay, and is 12 miles to the northward of Boston entrance. Gales Point on the northeast and Marblehead Neck on the southeast form, respectively, the northern and southern points of the entrance of the long indentation which comprises Manchester, Beverly, Salem and Marblehead harbors.

Three channels lead to Salem Harbor. The most northerly is the main ship-channel, and the entrance is between Great Misery Island on the north and Baker's Island on the south—the latter island being marked by a light-house. Opposite Hospital Point Light, on the north shore, the main ship-channel changes direction to southwest and passes into Salem Harbor, which lies almost due east of Salem. The other two channels enter the main ship-channel from the southeast, outside of the middle ground, southeast from Hospital Point light-house. The harbor inside of Nawgus Point is 1½ miles long and one-half mile wide, and has good anchorage for vessels drawing 20 feet mean low water. From the 14-foot curve of the anchorage to the entrance to South River at Derby Wharf Light the distance is one-half mile approximately. South River, upon which the principal wharves of the port are located, is a small river which formerly drained a small tidal basin on the southwestern side of the city, now practically filled up by city improvements. The stream is half a mile long and 250 feet wide, and is nearly dry throughout at mean low water. The head of navigation is South Bridge, Lafayette street, Salem.

The river and harbor act June 10, 1872, provided for the survey "of the channel and bank at entrance of Salem Harbor." The survey was made August-September, 1872, and a report containing a project for improvement submitted to the Department December 16, 1872 (Annual Report Chief of Engineers, 1873, page 1109). The project comprised the excavation of a channel 1,730 feet long, 300 feet wide, and 8 feet deep, mean low water, from 8-foot curve of the anchorage to the entrance to South River, at an estimated cost of $32,000, and the construction of a sea-wall and breakwater for the protection of Long Point (south side of entrance), at a cost of $23,000.

The river and harbor act of March 3, 1873, appropriated $15,000, which was applied 1873–1874 towards the execution of the project by dredging a channel of the required depth of 8 feet, with a width of 160 feet. The amount necessary to complete the dredging, by revised estimate, was $20,000. (Annual Report Chief of Engineers, 1874, Part I, page 111.)

The river and harbor act June 23, 1874, appropriated $10,000 for continuing the improvement, and the project for its application was completed by dredging April 20, 1875. (Annual Report Chief of Engineers, 1875, Part II, page 403.)

No report of this harbor has been published since 1877, and no sur-

vey or work of improvement has been made since operations were suspended in 1875.

The officer in charge reported in 1877 (Annual Report Chief of Engineers, 1877, page 172), that no additional sum was needed for improvement.

The outer anchorage is a place of frequent resort by vessels as a place of refuge during storms and thick weather.

Commercial statistics of Salem Harbor.

1869.—Vessels boarded		1,524
Aggregate tonnage	tons..	170,995
1870.—Vessels boarded		1,812
Aggregate tonnage	tons..	213,514
1876.—Revenue collected		$17,920.78
Value of imports		$46,974.00
Value of exports		$78,210.00
1888.—Revenue collected		$29,687.14
Five hundred and ninety-eight American and one hundred foreign vessels discharged cargoes, with an aggregate tonnage of tons..		225,000

A personal examination of the harbor has been made, and it has been ascertained from the collector of the port that the citizens desire a "general dredging of the entire harbor and the removal of 300 feet of ledge of rocks of what is called Long Point, South Salem, * * * as this point lies directly in the pathway of vessels bound to all the docks between South Bridge, South River, west of Derby's Wharf." The money value of the interests which will be benefited by the improvement is estimated at $10,000,000.

The harbor is "worthy of improvement," and I recommend an allotment of $700 for making a survey of the harbor and for preparing a project for the improvement, which will provide for a channel 10 feet deep, mean low water, from the anchorage to the head of navigation, 200 feet wide at the entrance, and gradually reduced to 100 feet on the inside; and also for a special examination of Long Point Shoal, with a view of determining whether it will be expedient to remove the rocky ledge which now offers a serious obstruction to navigation.

Very respectfully, your obedient servant,

G. L. GILLESPIE,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

SURVEY OF SALEM HARBOR, INCLUDING SOUTH RIVER, MASSACHUSETTS.

UNITED STATES ENGINEER OFFICE,
Boston, Mass., December 2, 1889.

GENERAL: I have the honor to forward herewith a report of Mr. Sophus Haagensen, assistant engineer, on the survey of Salem Harbor, including South River, Massachusetts, made in accordance with Department instructions dated April 1, 1889, and to comply with the provisions of the river and harbor act of August 11, 1888.

A tracing* of the survey is also submitted, on which has been indicated the proposed project for improvement.

The report of the preliminary examination is dated November 1, 1888,

* Omitted. Printed in House Ex. Doc. No. 28, Fifty-first Congress, first session.

and I respectfully invite attention to it for a general description of the harbor, for the previous project of improvement and expenditures under it, and for the reasons for making the present survey.

The survey shows that the channel of approach to South River, which was dredged in 1873–'75, has very slightly shoaled, but essentially preserved its original dimensions. It also shows that South River has been contracted by wharves, etc., to such an extent that in places but 65 feet of channel space is available; and that the foundations of these wharves would need very extensive strengthening to enable a 10-foot channel, as suggested in the preliminary report, to be dredged to the head of navigation.

The survey also shows that Long Point Shoal is not ledge, but hard pan, and that it can be almost entirely avoided and still permit an amply wide channel of approach.

With these facts and the character of the vessels frequenting the port in view, the project of improvement which I have the honor to propose is as follows:

To clean out the channel of approach to South River to the original dimensions as dredged in 1873–'75, viz, 300 feet wide at the entrance and 150 feet wide off Derby Wharf Light, 8 feet deep at mean low water; to extend this channel with same depth, gradually reducing its width to 100 feet, to near the inner end of Derby Wharf, and from this point to the head of navigation excavate a channel 50 feet wide and 6 feet deep at mean low water.

The total length of the channel to be improved will be approximately 5,100 feet, and its excavation will require the removal of 85,000 cubic yards of material, at an estimated cost as follows:

Dredging 85,000 cubic yards, at 30 cents	$25,500
Contingencies	2,500
Total	28,000

I respectfully invite attention to the accompanying report of Mr. Sophus Haagensen, assistant engineer, for the details of the survey and a general description of the harbor.

Salem Harbor, including South River, Massachusetts, is in the collection district of Salem, Mass, of which Salem is the port of entry. The nearest light-house is Derby Wharf Light, Salem Harbor, Massachusetts.

Very respectfully, your obedient servant,

S. M. MANSFIELD,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. SOPHUS HAAGENSEN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Boston, Mass., November 11, 1889.

COLONEL: I have the honor to submit the following report on the survey of Salem Harbor, Massachusetts, including South River, made in September, 1889, in pursuance of your instructions, together with a map of the survey drawn to a scale of 1:2500.

TOPOGRAPHY.

A base line 1,448 feet long was measured along Derby Wharf. Six triangulation stations were located and occupied, the angles being repeated at least three times.

From these points a system of ranges was arranged on which soundings in the har-

bor were taken. Two of these points—Fort Pickering Light and Derby Wharf Light—are United States Coast Survey points, and from them the projection on the map was fixed.

A plane table survey was made of the high-water and wharf lines of Salem, South River, on a scale of 1 : 2000, and reduced to the scale of the map.

The high-water and low-water lines of Salem Harbor were taken from the United States Coast Survey map of 1851.

HYDROGRAPHY.

The area covered by the survey includes all of Salem Harbor of a greater depth than 6 feet at mean low water, southwest of a line drawn from Fort Pickering Light to Naugus Head, and South River to its head.

In Salem Harbor 52 ranges aggregating 15 miles in length were sounded, on which 5,078 soundings were taken, 655 of which were intersected with a transit from suitable shore stations.

Twenty-one of these ranges, on which 878 soundings were taken, were designed to cover the location of the channel of approach dredged by the United States in 1873-1875 from the 8-foot contour at the head of the harbor to the mouth of South River at the end of Derby Wharf, in order to determine its present condition.

In South River 81 ranges were sounded from corner to corner of the wharves, 1,521 soundings being taken.

The soundings are expressed in feet and tenths, and refer to mean low water. The bench-mark is the top of the tenth course of brick-work of the Derby Wharf light-house, 13.97 feet above mean low water.

DESCRIPTION OF SALEM HARBOR AS DEVELOPED BY SURVEY.

Fort Pickering Light marks the entrance of Salem Harbor, between Winter Island on the west and Naugus Head on the east. The harbor is 1,750 feet wide at its entrance, and 5,500 feet long between the 12-foot contours of opposite shores. It contains a well-sheltered and entirely unobstructed anchorage-ground of about 110 acres extent, of a greater depth than 18 feet, mean low water. In front of the city lie extensive flats, making low wharves necessary to reach the deep water of the harbor. Of these the Philadelphia and Reading Coal and Iron Company's Wharf and Derby Wharf are the most important. On the outer end of Derby Wharf a small light-house called Derby Wharf Light marks the mouth of South River, which is reached from deep water at the head of the harbor by a channel dredged by the United States in 1873–1875. This channel when completed was 1,730 feet long, 8 feet deep at mean low water, and 300 feet wide, with the exception of the inner end, which was gradually contracted to 175 feet as it entered the mouth of South River between the end of Derby Wharf and Long Point.

The survey shows that the channel has essentially preserved its original dimensions, but a shoaling is noticeable, particularly on the northern side, and at its outer end a slight bar has formed with a greatest depth of 7.3 feet at mean low water. Passing Derby Wharf Light, South River extends in a general westerly direction for 3,000 feet through the city of Salem to South or Lafayette Street Bridge, which is the head of navigation. The river is completely bounded by wharves, on which the bulk of the water freights is discharged, and is crossed by one bridge below the South or Lafayette Street Bridge with a draw-opening of 31.5 feet in the clear. A low-water channel with a greatest continuous depth of 0.8 foot extends from its mouth to the head of navigation.

Borings were made at 11 stations in South River to determine the character of the bottom, the results being recorded in the table of borings annexed.

In addition to these, 21 stations in the excavated channel of approach, at which borings were made in the survey made by the United States engineers in 1873, have been transferred to this map and the results then obtained recorded in the table of borings Nos. 12–32, inclusive.

A special examination of Long Point Shoal was made. It consists of hard pan, in and on which are bowlders varying from a few pounds to 8 tons. No solid ledge was discovered.

Very respectfully, your obedient servant,

SOPHUS HAAGENSEN,
Assistant Engineer.

Lieut. Col. S. M. MANSFIELD,
Corps of Engineers, U. S. A.

Table of borings.

No.	Sounding.	Material.	To a depth of—	Then through—	To a total depth of—
1	1.0	Gravel	6.5	Clay	8.0
2	1.0	Mud and sand	5.0	Sand and gravel to clay	6.8
3	1.5	Mud and gravel	5.5	Gravel into clay	7.6
4	1.3	Mud and sand	4.3	Sand and gravel into clay	6.7
5	1.5	Mud and gravel	7.5	Clay	8.5
6	8.0	Mud and sand	8.0	Hard pan	9.0
7	2.1	do	9.1	Clay	10.1
8	2.5	Mud	6.5	Sand	9.4
9	1.5	Soft mud and clay			9.0
10	2.5	Mud and sand			8.1
11	3.0	Soft mud and clay			8.8
12	0.0	Hard pan			0.5
13	4.0	Mud			7.0
14	4.8	do			6.8
15	6.5	do			9.5
16	4.0	Stiff clay			8.4
17	3.3	Mud			9.8
18	4.3	do			9.8
19	4.8	do			9.8
20	7.5	do			10.0
21	6.5	do			10.0
22	7.3	do			10.3
23	5.3	do			10.3
24	6.5	do			10.5
25	6.0	do			10.5
26	5.5	do			10.5
27	6.0	do			10.5
28	6.0	do			10.5
29	6.5	do			10.5
30	6.0	Sticky mud			10.5
31	6.5	Mud			10.5
32	7.0	do			10.5

NOTE.—Borings are expressed in feet and tenths below mean low water. Borings Nos. 12 to 32, inclusive, are taken from the United States engineer survey of 1872. The locations of boring stations are indicated on the map by circles and figures, thus: ⊙ 32.

B 21.

ESTABLISHMENT OF HARBOR LINES AT BOSTON HARBOR, MASSACHUSETTS.

a. HARBOR LINES FOR DORCHESTER BAY FROM SOUTH BOSTON TO MOON ISLAND, AND FOR LEFT BANK OF CHARLES RIVER BASIN FROM GRAND JUNCTION RAILROAD BRIDGE TO THE NAVY-YARD.

UNITED STATES HARBOR LINE BOARD,
Boston, Mass., January 28, 1890.

GENERAL: The Harbor Line Board for Boston Harbor, Massachusetts, constituted by Special Orders, No. 38, Headquarters Corps of Engineers, August 13, 1888, at its session held in this city to-day, has considered Dorchester Bay from South Boston to Moon Island, and the left bank of the Charles River Basin from the Grand Junction Railroad bridge to the navy-yard, and has the honor to submit for the approval of the Secretary of War certain harbor lines which are delineated upon the accompanying charts.

For Dorchester Bay between a point C at City Point and a point Y on Neponset River the pier-head lines coincide with the lines now fixed by the laws of Massachusetts, in chapters 293 of the acts of 1856, 351 of the acts of 1872, and 332 of the acts of 1873.

On the right bank of the Neponset, between the Neponset Avenue

Bridge and the mouth, the pier-head line recommended follows the line established by the State in its general features, but modified to give a gradual increase of width to the water-way near the mouth in accordance with the best modern practice in the case of tidal streams.

Between the mouth of the Neponset River and the sewerage outlet on Moon Island the State has never defined harbor lines; this has been done by the Board, after several public meetings and full consultation with the riparian proprietors, in a manner which it is believed will protect the general interests of the harbor and serve the local needs of the district in question.

The State of Massachusetts has never fixed bulkhead as distinguished from pier-head lines. The Board has deemed it best to do so, and the accompanying maps sufficiently indicate the proposed location of the bulkhead lines beyond which it is understood that no solid constructions shall hereafter be extended.

On the left bank of the Charles River Basin, between Grand Junction Railroad Bridge and Craigie's Bridge, the pier and bulkhead line has been drawn to coincide with the line established by the State legislature.

The tidal prism of the Charles River Basin has already been unadvisedly reduced, and this line contemplates a still further reduction; moreover, the forest of piles driven in the water-way below interferes with the current at the mouth of the river. A comparison of the survey of 1888 with that of 1861 shows a shoaling below the bridges of 712,415 cubic yards, reducing the average depth by 3.66 feet over an area of more than 120 acres.

Several Boards and all the officers of the Corps of Engineers, who for many years have discussed and reported upon this subject, have insisted upon the preservation of the Charles River Basin as a tidal reservoir for the maintenance of the channels of the harbor. But heretofore the General Government has never exercised the right to control and direct this matter, although the fact of these encroachments has been officially placed on record. Meanwhile the State of Massachusetts has authorized the filling up of this basin to the line above mentioned without a corresponding enlargement of the tidal prism in other places, and has granted privileges involving a great outlay of capital. To move the pier and bulkhead line back as would be desirable for the "protection and preservation of the harbor," would therefore interfere with vested rights of great value. In granting these privileges the State of Massachusetts has virtually assumed the responsibility for any injury to the harbor that has accrued or may accrue from this cause, and the Board therefore recommends for the approval of the Secretary of War the lines above indicated.

From Craigie's Bridge to the navy-yard at Charlestown, the Board has deemed it expedient for the "preservation and protection of the harbor" to establish a bulkhead line, as well as a pier-head line. These two lines coincide as far as Warren Bridge, and up to the Eastern Railroad Bridge conform to the existing harbor line enacted by State law. Beyond the Eastern Railroad Bridge the State harbor line is abandoned, and the new lines, located coincidently, assume a new direction, closer to the original shore-line, as far as Warren Bridge. Eastward of Warren Bridge the pier-head line coincides with the State harbor line as far as the navy-yard, while the bulkhead line follows a nearly parallel course to the northward, at a distance of 600 feet, approximately. The State line and the proposed lines are delineated upon accompanying charts.

The harbor lines which are recommended for adoption are defined as follows:

I.—DORCHESTER BAY—PIER-HEAD LINES.

The pier-head line commences at a point marked C, which is in the westerly line of P street, South Boston, extended southwardly and 530 feet from the southerly line of Sixth street; thence southwestwardly again to the point D, in the easterly line of M street extended southwardly, and 1,300 feet from the southerly line of Eighth street; thence westwardly parallel with Eighth street, to the point E, in the easterly line of Old Harbor street extended southwardly; thence southwardly 1,400 feet to the point F, in the easterly line of Old Harbor street extended southwardly; thence eastwardly, making an angle of 104° (taken from a northerly to an easterly direction) with the line last described, to the point G, in the easterly line of M street extended southwardly; thence 3,200 feet to the point H, in the easterly line of M street extended southwardly; thence southwestwardly 2,320 feet, making an angle of 124° (taken from a northeastwardly to a southwestwardly direction) with the line last described, to a point marked X'; thence continuing 1,900 feet westwardly a little more southwardly, making an angle of 5° 15' with the line last described, extended to the point marked I^2; thence westwardly in a straight line, which, extended would strike the east side of the embankment of the Old Colony and Newport Railroad 515 feet northwardly from the north side of the present water-way through said embankment, to a point 500 feet eastwardly from the east side of said embankment marked J^2; thence southwardly 590 feet parallel to the east side of said embankment to a point marked K^2; thence southeastwardly in a straight line to the point marked L, which is distant 200 feet from the northeasterly corner of Ranstead, Dearborn and Company's Wharf (as built in 1856), measuring at right angles with the northeasterly end of said wharf; thence southwardly to the point M, distant 1,350 feet from the northeasterly rail of the Old Colony Railroad, measuring at right angles therewith from a point distant 4,000 feet northwestwardly from the draw in their bridge over Neponset River; thence southeastwardly to the point N, distant 1,200 feet from said rail, measuring at right angles therewith from a point distant 3,300 feet northwestwardly from said draw; thence southeasterly to the point O, which is distant 1,460 feet from the said rail, measuring at right angles therewith from a point distant 2,670 feet northwestwardly from the said draw; thence southeastwardly again to the point P, distant 1,630 feet from said rail, measuring at right angles therewith from a point distant 2,150 feet northwestwardly from said draw; thence southeastwardly again to the point Q, distant 1,700 feet northeastwardly from said rail, measuring at right angles therewith from a point distant 1,600 feet northwestwardly from said draw; thence southeastwardly again to the point R, distant 1,590 feet northeastwardly from said rail, measuring at right angles therewith from a point 1,090 feet northwestwardly from said draw; thence southeastwardly to the point S, distant 1,340 feet northeastwardly from said rail, measuring at right angles therewith from a point distant 630 feet northwestwardly from said draw; thence southerly to the point T, distant 1,140 feet northeastwardly from said rail, measuring at right angles therewith from a point distant 380 feet northwestwardly from said draw; thence southwestwardly to the point U, distant 850 feet northeastwardly from said rail, measuring at right angles therewith from a point distant 270 feet northwestwardly from said draw; thence southwestwardly again to the point W, on the southeastwardly corner of James Jenkins's Wharf, formerly so called; thence southwestwardly again to the point X, on the southeasterly corner of W. H. Chamberlin's Wharf, formerly so called; thence continuing southwestwardly along the southeastwardly ends of said Chamberlin's Wharf and of Edward Preston's Wharf, formerly so called, to the point Y, on the eastwardly side of the Neponset Bridge.

On the easterly side of Neponset River the line begins at the point A' on the easterly side of the Neponset Bridge, and 400 feet southerly from the point Y on the west side of the river; thence in a straight line to the point B' on the northeasterly side of the Old Colony Railroad Bridge, distant 400 feet southeastwardly from the line W-X on the opposite side of the river, between the points W and X, measuring at right angles from said line; thence northeastwardly parallel to the line W-U, on the opposite side of the river to the point C', distant 400 feet southeastwardly from the point U, measuring at right angles to the line W-U; thence northeastwardly again to the point D', distant 450 feet southeastwardly from the opposite point T, measuring on a line bisecting the angle at said point T; thence northwardly to the point E', distant 450 feet eastwardly from the opposite point S, measuring on a line bisecting the angle at said point S; thence north a little westerly to the point F', distant 450 feet eastwardly from the opposite point R, measuring on a line bisecting the angle at said point R; thence northerly a little more westerly to the point G', distant 500 feet easterly from the opposite point Q, measuring on a line bisecting the angle at said point Q; thence northwesterly to the point H', distant 650 feet northeasterly from the op-

posite point P, measuring on a line bisecting the angle at said point P; thence northwesterly to the point I′, distant 700 feet northeasterly from the opposite point O, measuring on a line bisecting the angle at O; thence northwesterly to the point J′, distant 900 feet northeasterly from the opposite point N, measuring on a line bisecting the angle at N; thence northwesterly to the point K′, distant 900 feet easterly from the point M, measuring on a line bisecting the angle at M; thence northeasterly to the point L′, distant 1,000 feet from the point L on the west side of the river, measuring on a line perpendicular at L to the line L-M; thence to the point M′, which is in the easterly side of M street, South Boston, prolonged southwardly 3,150 feet from the point H near the west shaft of sewer tunnel; thence due east to the point N′, which is 3,000 feet due west from Squantum Coast Survey Point; thence easterly to the point O′, which is 500 feet due north from Squantum Coast Survey Point; thence due east 4,000 feet to the point P; thence to the north corner of the sewerage outlet at Moon Head.

II.—DORCHESTER BAY—BULKHEAD LINES.

The bulkhead line is coincident with the pier-head line from the point C to the point F.

From F it runs southwardly in a straight line to the point I, which is on the line which bisects the angle at G of the pier-head line and 600 feet west of the line G-H of the pier-head line; thence parallel to the pier head line G-H, and 600 feet within it, to a point on the line bisecting the angle at H of the pier-head line; thence parallel to the pear-head line H-X′ for a distance of 1,300 feet; thence turning by an angle of 105°, measuring from an easterly to a northerly direction, and running 2,000 feet; thence turning by an angle of 105°, measuring from a southerly to a westerly direction, and running 600 feet; thence turning by an angle of 86°, measuring from an easterly to a southerly direction, and running 1,965 feet; thence turning an angle of 91° 15′ measuring from a northerly to a westerly direcction, and running 1,600 feet to a point marked II, which is at the intersection of two lines, one a line parallel to the pier-head line X^1-I^2, and 600 feet within it, and the other parallel to the pier-head line I^2-J^2, and 400 feet within it; thence parallel to the line I^2-J^2, and 400 feet from it inland, to the easterly side of the Old Colony Railroad embankment; thence along the easterly side of said embankment to a point 160 feet southward of the draw-opening; thence eastwardly parallel to K^2-L of the pier-head line to the point III. The point III is in the line last described (parallel to K^2-L) at its intersection with the north face of the Boston Gas Company's Wharf, prolonged 920 feet westerly from the northeastern corner of said wharf; thence the line follows the faces of said wharf to an intersection with the pier-head line L–M, 250 feet southerly from L; thence the bulkhead and pier-head lines are coincident to the point IV, which is 1,000 feet southward from the point L; thence in a straight line parallel to South street and 200 feet from the south side of said street to a point on the eastern side of Commercial Street Bridge; thence along the east side of Commercial Street Bridge 750 feet; thence to the point V, which is distant 900 feet northeastwardly from northeastern rail of the Old Colony Railroad, measuring at right angles therewith, at a point distant 3,300 feet northwestwardly from the draw in the bridge over the Neponset River; thence to the point VI which is distant 1,350 feet northeastwardly from said rail, measuring at right angles therewith, at a point distant 2,150 feet northwestwardly from said draw; thence to a point distant 1,400 feet northeastwardly from said rail, measuring at right angles therewith from a point distant 1,600 feet from said draw; thence to a point distant 1,250 feet northeasterly from said rail, measuring at right angles therewith, from a point distant 1,090 feet northwesterly from said draw; thence to the northeast corner of the sea-wall of Stearn's lumber wharf; thence to a point 155 feet northwesterly from the point W of the pier-head line, measuring along the northeastern face of said wharf; thence the bulkhead line is parallel to and 155 feet distant from the pier-head lines to the city highway bridge over Neponset River.

On the easterly side of Neponset River the bulkhead line starts at a point on the east side of the highway bridge over Neponset River, 750 feet southeast from the point Y, measuring along the east side of said bridge, and runs in a straight line to a point in the east side of the Old Colony Railroad Bridge 350 feet southeastward from the point B′ of the pier-head line, measuring along the east side of said bridge; thence to the point VII, which is 350 feet distant from the point C′ of the pier-head line, measuring on a perpendicular to the pier-head line B′–C′ at C′; thence to the point VIII, which is 350 feet distant from the point D′ of the pier-head line, measuring on a perpendicular to the pier-head line C′–D′ at D′; thence to the point IX, which is in the pier-head line B′–C′ extended eastwardly 1,050 feet from C′; thence to the point X, which is distant 2,420 feet from the northeasterly rail of the Old Colony Railroad, measuring perpendicular thereto, at a point 1,090 feet from the draw in the bridge over the Neponset River; thence to the point XI, which is distant 2,775 feet northeasterly from said rail, measuring at right angles therewith, from a point distant 3,300 feet from said draw; thence the bulkhead line is parallel to the pier-head line,

and 600 feet within it, to a point XII, which is at its intersection with the foot of the outfall sewerage embankment, near point P′ of the pier-head line; thence along said foot of the embankment to the north corner of the sewerage outlet, where the bulkhead and pier-head lines meet.

III.—LEFT BANK OF CHARLES RIVER, BETWEEN GRAND JUNCTION RAILROAD BRIDGE AND THE NAVY-YARD.

Beginning at a point on the northerly side of West Boston Bridge at its intersection with the face of the wharf, and marked by a copper tack through an iron plate on the cap outside of the brick sidewalk, and indicated on the plan by the letter A; thence running southwesterly on a curve of 951.34 feet radius (tangent to a line to be hereafter described running between West Boston and Craigie's bridges) for a distance of 503.01 feet; thence continuing southwesterly on a straight line tangent to said curve for a distance of 6,838.19 feet; thence westerly on a curve of 1,200 feet radius, tangent to the last named line for a distance of 496.97 feet; thence westerly on a straight line tangent to the last named curve to the Grand Junction Railroad Bridge. Again beginning at the point on the northerly side of West Boston Bridge marked A (previously described); thence northeasterly to point B, which is on the southerly side of Craigie's Bridge at its intersection with the face of the wharf, and is marked by a copper tack through an iron plate on the cap outside of the sidewalk, and is referred to point B,′ which is at the southeasterly corner of the Boston and Lowell machine-shop, distance from B to B′ 73.39 feet; bearing from B to B′ 224° 46′ 12.″ Thence northeasterly to point C at the southerly side of the Boston and Lowell Railroad passenger bridge at its intersection with the face of the wharf, and is marked on the cap-sill of the bridge by a copper tack through an iron plate; thence the line continues northeastwardly to the point C′.

The point C′ is 58 feet southerly (measuring along the face of the solid bulkhead) from the intersection of the line B–C just described, prolonged to an intersection with the solid bulkhead of the Fitchburg Railroad Bridge; C′ is 853 feet approximately northeasterly from C.

From C′ the line follows the faces of the solid bulkhead of the Fitchburg Railroad in an easterly direction to the point D′, which is at the intersection of said solid bulkhead with the westerly side of Warren Bridge.

At the point D′ the pier and bulkhead lines separate: The pier-head line lies in the west face of Warren Bridge, to the point D, which is about 66 feet southerly from the outer face of the wharf on the same westerly side of Warren Bridge, and is marked by a copper tack through an iron plate; thence the pier-head line extends to the point E, which is at the easterly side of Charles River Bridge, about 80 feet southerly from the outer face of Tudor's Wharf, on the same easterly side of said Charles River Bridge, and is marked by a copper tack through an iron plate thence northeasterly to the point F, which is about 80 feet southeasterly from the southwesterly corner of Hittinger's Wharf, and nearly in the alignment of the westerly side of said Hittinger's Wharf, produced and is referred to point E; distance from point F to point E, 379 feet; bearing from point F to point E is 59° 6′ 27″; thence northeasterly to point G which is at the southwesterly corner of the navy-yard shears wharf, and is referred to point G′ which is near the same southwesterly corner of the said navy-yard shears wharf, and is marked by a copper tack through an iron plate; distance from G to G′ 1.40 feet; bearing from G to G′ 150° 35′.

From the point D′ the bulkhead line runs northeasterly in a straight line (parallel to the pier-head line F–G) 1,470 feet approximately to an intersection with the boundary wall of the navy-yard.

Respectfully submitted.

HENRY L. ABBOT,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.
G. L. GILLESPIE,
Lieut. Col. of Engineers.
S. M. MANSFIELD,
Lieut. Col. of Engineers.
W. R. LIVERMORE,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
February 12, 1890.

Respectfully submitted to the Secretary of War.

The Harbor Line Board for Boston Harbor, Massachusetts, constituted by Special Orders No. 38, Headquarters Corps of Engineers, August 13, 1888, at its session held in Boston, January 28, 1890, adopted and recommends for the approval of the Secretary of War the following harbor lines, described in the within report and delineated upon the accompanying charts:

1. Dorchester Bay, pier-head lines.
2. Dorchester Bay, bulkhead lines.
3. Left bank of Charles River, between Grand Junction Railroad Bridge and the navy-yard.

It is recommended that the lines selected be approved, and that the Secretary place his approval both upon the report and the tracings submitted.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Second indorsement.]

WAR DEPARTMENT,
February 13, 1890.

Approved.

REDFIELD PROCTOR,
Secretary of War.

---

b. HARBOR LINES FOR CHARLES RIVER, MASSACHUSETTS.

UNITED STATES HARBOR LINE BOARD,
Boston, Mass., March 7, 1890.

GENERAL: The Harbor Line Board for Boston Harbor, Massachusetts, constituted by Special Orders No. 38, Headquarters Corps of Engineers, August 13, 1888, at its session held in this city to-day has considered Charles River from the lines established by the Secretary of War, near the Brookline Street Bridge to Market Street Bridge, and has the honor to submit for the approval of the Secretary of War certain harbor lines which are delineated upon the accompanying chart.

The State of Massachusetts has never established lines upon this portion of the river, but the Board has deemed it necessary to do so. The lines recommended are indicated upon the chart and described as follows:

THE LINE ON THE NORTH SIDE OF THE CHARLES RIVER

begins at the Grand Junction Railroad Bridge, at the intersection of the east side of the bridge and the harbor-line approved by the Secretary of War February 13, 1890; thence in a straight line, making an angle with the harbor line above referred to of 166° 20′, measuring from a northeasterly to a northwesterly direction, 1,020 feet approximately, to the point B, which is situated on a line parallel to and 600 feet north of the northeastern rail of the main line of the Boston and Albany Railroad; thence parallel to said rail 675 feet to the point C; thence to the point D by the arc of a circle of 860 feet radius, tangent to the line last described, said arc subtending an angle at the center of 64° 45′, measuring from a southwesterly to a westerly direction; thence on a tangent to the last described circle, 850 feet to the point E, said tangent on the line DE, if produced, will intersect the east side of River Street Bridge produced 155 feet northeastward from the face of the easterly stone abutment of said

bridge; thence to the point F, at the southeast corner of said abutment; thence following the face of said abutment and the faces of the stone wharf of the Riverside Press Company to the point G, at the northwest corner of said stone wharf; thence to the point H, which is the northwest corner of the solid abutment of Western Avenue Bridge on the Cambridge side; thence to the point I, which is in the line of the south side of the first street north of Sands street (Cambridge), extended westerly 320 feet from the west side of Banks street; thence to the point J, which is 400 feet from the west side of Banks street, measuring westerly, along the south side of the second street north of Sands street; thence to the point K, which is at the southeast corner of the wharf at the foot of Otter street; thence to the northwest corner of said wharf; thence to the southeast corner of Wellington's Wharf; thence to the southwest corner of said wharf; thence to the west corner of College Wharf; thence to the east corner of the solid abutment of the Brighton Street Bridge on the Cambridge side; thence to the point L, which is in the line of the west side of that part of Murray street which runs southwesterly, extended southwesterly 760 feet from the south side of Lyman street; thence to the point M, which is in the line of the north side of that part of Murray street which runs southeasterly, extended northwesterly 830 feet from the west side of Brighton street; thence to the southeast corner of the Cambridge Gas Company's Wharf; thence to the point N, which is in the line of the east side of Willard street, extended southerly 180 feet from the north side of Mount Auburn street; thence to the point O, which is 115 feet from the north side of Mount Auburn street, measuring at right angles therewith from a point 155 feet west of the west corner of Willard street; thence parallel to Mount Auburn street 315 feet to the point P; thence to the southeast corner of the Monument Wharf, marked Q on the tracing.

THE LINE ON THE SOUTH SIDE OF THE CHARLES RIVER

begins at the northeast corner of the solid part of Abbot's Wharf, near Brookline Street Bridge, and at the end of the harbor-line approved by the Secretary of War July 27, 1889; thence in a straight line 280 feet to the point B′, which is 120 feet distant from the northerly rail of the Boston and Albany main track; thence parallel to said rail 830 feet to the point C′; thence to the point D′, by the arc of a circle of 1,200 feet radius, tangent to the line last described, said arc subtending an angle of 66° 12′ at the center, measuring from a southwesterly to a westerly direction; thence tangent to the circle last described 915 feet to the point E′, said tangent if produced will intersect the east side of River Street Bridge, 65 feet more or less, northeast from the solid abutment of the bridge on the Boston side; thence to the point F′, at the north corner of the solid abutment of Western Avenue Bridge on the Boston side; thence parallel to the line HI on the opposite side of the river, 500 feet to the point G′; thence to the point H′, which is 315 feet distant from the opposite point J, measuring on a line at right angles to the line IJ at J; thence to the point I′, which is 280 feet distant from the opposite point K, measuring on a line perpendicular to the face of the wharf at K; thence to the point J′, which is 300 feet from the northwest corner of the opposite wharf, measuring perpendicular to the face of the wharf at said corner; thence to the point K′, which is 300 feet from the east corner of Wellington's Wharf, measuring on a line perpendicular to the face of said wharf, at said corner; thence to the point L′, which is 320 feet from the west corner of College Wharf, measuring on a line perpendicular at said corner to the line joining said corner with the west corner of Wellington's Wharf; thence to the east corner of the solid wharf east of Brighton Street Bridge; thence along the faces of said stone wharf to the abutment of the Brighton Street Bridge and the face of the stone wharf west of said bridge, and continuing in said line 280 feet from west side of bridge to a point marked M′, the line last described makes an angle of 76° 26′ approximately with the west side of Brighton Street Bridge, measuring from a southwesterly to a westerly direction; thence to the point N′, which is 340 feet from the opposite point L, measuring on a line bisecting the angle at L; thence to the point O′, which is 340 feet from the opposite point M, measuring on a line perpendicular to the line joining the point M with the southeast corner of the gas wharf; thence to the point P′, which is 240 feet from the southeast corner of said wharf, measuring on a line perpendicular to the face of said wharf at this corner; thence to the point Q′, which is in the east line of Willard street, extended southward, 420 feet from the north side of Mount Auburn street; thence to the point R′, which is 320 feet from the north side of Mount Auburn street, measuring on a line perpendicular thereto, through the opposite point O; thence to the point S′, which is distant 210 feet from the opposite point P, measuring on a line bisecting the angle at P; thence to the point T′, which is 200 feet distant from the east corner of Monument wharf, marked Q on tracing, measuring on a line perpendicular to the line joining said corner with the point P.

Above the points Q and T the lines follow the meanderings of the river as laid *down on the map.* They are parallel and 200 feet apart to the northwestern corner

of Cassedy's Wharf, near Arsenal Street Bridge; thence they gradually narrow to 140 feet at the bridge and preserve this width to Market Street Bridge.

Respectfully submitted.

HENRY L. ABBOT,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.
G. L. GILLESPIE,
Lieutenant-Colonel of Engineers.
S. M. MANSFIELD,
Lieutenant-Colonel of Engineers.
W. R. LIVERMORE,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
March 13, 1890.

Respectfully submitted to the Secretary of War.

The Harbor-Line Board for Boston Harbor, Massachusetts, constituted by Special Orders No. 38, Headquarters Corps of Engineers, August 13, 1888, recommends for the approval of the Secretary of War the following harbor-lines described in the within report and delineated upon the accompanying chart:

1. North side of Charles River from Grand Junction Railroad Bridge to Market Street Bridge.
2. South side of Charles River from Abbot's Wharf, near Brookline Street Bridge, to Market Street Bridge.

It is recommended that the lines selected be approved and that the Secretary place his approval both upon the report and the tracing submitted.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Second indorsement.]

WAR DEPARTMENT,
March 17, 1890.

Approved.

REDFIELD PROCTOR,
Secretary of War.

---

c. HARBOR-LINES FOR MYSTIC RIVER WITH ITS TRIBUTARIES AND CHELSEA CREEK.

UNITED STATES HARBOR-LINE BOARD,
Boston, Mass., May 23, 1890.

GENERAL: The Harbor-Line Board of Boston Harbor, Massachusetts, constituted by Special Orders No. 38, Headquarters Corps of Engineers, U. S. Army, August 13, 1888, at its session held in this city April 23, 1890 considered the Mystic River with its tributaries and Chelsea Creek, and has the honor to submit for the approval of the Secretary of War certain harbor-lines which are delineated upon the accompanying charts, Harbor-Line Board sheets J and L, and described herewith.

The State of Massachusetts has established lines upon a portion of these waters only, and they are delineated in broken lines upon the charts where they do not coincide with the lines recommended by this Board, and all are referred to in the descriptions.

The meetings of the Board on March 6 and April 22 were duly advertised for the purpose of public consultation with all persons interested in the establishment of harbor-lines for these waters.

The term pier-head is applied to lines beyond which no pile structure shall extend, and the term bulkhead to lines beyond which no solid filling shall hereafter be permitted.

Respectfully submitted.

HENRY L. ABBOT,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.
G. L. GILLESPIE,
Lieutenant-Colonel of Engineers.
S. M. MANSFIELD,
Lieutenant-Colonel of Engineers.
W. R. LIVERMORE,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
June 4, 1890.

Respectfully submitted to the Secretary of War.

The Harbor Line Board for Boston Harbor, Massachusetts, constituted by Special Orders, No. 38, Headquarters Corps of Engineers, August 13, 1888, recommends for the approval of the Secretary of War the following harbor lines, described in the within report and delineated upon the accompanying chart:

1. Pier and bulkhead lines, south side of South Channel, Mystic River.
2. Pier and bulkhead lines, south side Mystic River.
3. Pier and bulkhead lines, Chelsea side of Mystic River and Chelsea Creek, between Chelsea Bridge and Meridian Street Bridge.
4. Pier and bulkhead lines, north side of Mystic River, between Chelsea Bridge and Boston and Maine Railroad bridge.
5. Bulkhead and pier-head lines, south side of Mystic River, above the Boston and Maine Railroad bridge.
6. Bulkhead and pier-head lines, north side of Mystic River, above Boston and Maine Railroad bridge.
7. Pier-head and bulkhead lines, Malden River.
8. Pier-head and bulkhead lines, Island End River.
9. Pier-head and bulkhead lines, East Boston side of Chelsea Creek, between Meridian Street Bridge and Chelsea Street Bridge.
10. Pier-head and bulkhead lines, Chelsea side of Chelsea Creek, between Meridian Street Bridge and Chelsea Street Bridge.
11. Pier-head and bulkhead lines, Chelsea side of Chelsea Creek, above Chelsea Street Bridge.
12. Pier-head and bulkhead lines, easterly side of Chelsea Creek, above Chelsea Street Bridge.

It is recommended that the lines selected be approved, and that the

Secretary place his approval both upon the report and the tracing submitted.

THOS. LINCOLN CASEY,
Brig. Gen. Chief of Engineers.

[Second indorsement.]

WAR DEPARTMENT, *June* 20, 1890.

Approved.

REDFIELD PROCTOR,
Secretary of War.

DESCRIPTION OF THE PIER-HEAD AND BULKHEAD LINES FOR MYSTIC RIVER, EXTENDING FROM THE MOUTH OF THE RIVER TO THE MEDFORD STREET BRIDGE, WHICH ARE RECOMMENDED FOR THE APPROVAL AND ADOPTION OF THE SECRETARY OF WAR BY THE HARBOR LINE BOARD FOR BOSTON HARBOR, CONSTITUTED BY SPECIAL ORDERS, NO. 38, HEADQUARTERS CORPS OF ENGINEERS, AUGUST 13, 1888, IN ITS REPORT DATED MAY 23, 1890.

South side of South Channel, Mystic River—Pier and bulkhead lines.—The pier and bulkhead lines are coincident, beginning at the northwesterly corner of the sea-wall of the United States navy-yard, and runs westerly in a straight line to the present northwesterly corner of Holmes' Wharf; thence continues westerly in a straight line to the present northeasterly corner of Stone's Wharf; thence continues westerly following and coinciding with the northerly face of said Stone's Wharf, and continues in the same direction to the present northeasterly corner of Clark & Smith's Wharf; thence continues westerly in a straight line to a point in the northeasterly line of Elm street produced northerly at the westerly end of said South Channel, and distant 150 feet southerly from the northwesterly corner of said channel as said channel is defined in chapter 481 of the acts of the general court of Massachusetts of the year 1855. This line coincides with the line established by the State in chapter 302, acts of 1874.

South side Mystic River—Pier and bulkhead lines.—Beginning at the point where the southeasterly line of Johnson's Wharf extended to the North Channel intersects a line drawn from the northeasterly corner of Tuft's mill-pond to a point on Chelsea Bridge 700 feet northerly from the northerly side of the south draw in said bridge; the line runs easterly 820 feet by an arc of a circle curving northerly, and having a radius of 3,500 feet; thence continues easterly by a straight line tangent to said arc, and in such a direction that it shall pass through a point on the northwesterly side of said bridge, 770 feet southerly of the southerly side of the north draw in said bridge, running by said straight line to a point 341 feet westerly of the westerly side of said bridge; thence running southeasterly by an arc of a circle turning southerly, and having a radius of 675 feet, said arc to be continued until a straight line, drawn tangent to said arc, would, if continued, pass through the northeasterly corner of the timber dock of the navy yard of the United States, said line tangent to be continued to the northerly side of the South Channel to a point 500 feet distant from said corner of said dock, and 817 feet distant from the easterly side of Chelsea Bridge by a line drawn at right angles with said bridge; thence running westerly by a straight line, which extended would strike the line of the northeasterly side of Elm street produced 500 feet from the northerly side of Medford street, measured on said northeasterly side of Elm street, to a point 320 feet easterly from said northeasterly side of Elm street produced; thence running southwesterly by an arc of a circle turning southerly and having a radius of 600 feet to a point on said easterly line of Elm street extended northerly 375 feet from the northerly side of Medford street. This line coincides with the line established by the State in chapter 481, acts of 1855, and chapter 150, acts of 1867.

The portion of the line thus described between its point of beginning and where it first intersects the easterly line of Elm street produced northerly to the channel, and a straight line drawn from this point of beginning to the northeasterly corner of Tuft's mill-pond is to be considered a pier-head line beyond which no pile structure shall be extended, and the remainder of the line above described is to be considered a bulkhead line beyond which solid filling shall not hereafter be permitted.

Beginning again at the point where the line above described first intersects the northeasterly line of Elm street produced northerly to the channel, the bulkhead line follows the line of the northeasterly line of Elm street produced northerly in a southerly direction to a point 600 feet distant from the pier-head line measured on a line at right angle thereto; thence, runs westerly in a line parallel to and 600 feet inside of the pier-head line to the easterly face of the wall bounding Tuft's mill-pond

on the east; thence along the face of this wall to the northeasterly corner thereof; thence the pier and bulkhead lines are coincident and follow the channel-face of Tuft's mill-pond wall to the southerly abutments of the Malden Bridge; thence along this solid abutment and its northeasterly face to the north corner thereof; thence in a straight line which, if produced, will strike the easterly corner of the solid filling of the Boston and Maine Railroad Company's coal dock above the Eastern Railroad bridge to the easterly face of the Eastern Railroad bridge; thence along the easterly face of this bridge to a point distant 375 feet northeasterly from the northeasterly corner of the solid abutment of said last-named bridge on the southerly side of the channel; thence the pier-head line runs northwesterly to a point on the easterly side of the bridge of the Boston and Maine Railroad, distant 625 feet northerly from the northeasterly corner of the solid abutment of said last-named bridge on the southerly side of the channel; and the bulkhead line between the Eastern Railroad Bridge and the Boston and Maine Railroad Bridge is parallel to and 30 feet within said pier-head line.

The pier-head line so described between the Eastern and Boston and Maine Railroad bridges coincides with the lines established by the State in chapter 231 of the acts of 1873.

The line of the channel wall of Tuft's mill-pond was established as a harbor line by chapter 293 of the acts of 1856. Between the south easterly line of Johnson's Wharf prolonged and Tuft's mill-pond, and between the Malden and Eastern Railroad bridges, the State has established no harbor line.

Beginning again at the point of intersection of the bulkhead lines of the northerly side of the South Channel and Main Channel, said point being 500 feet in a northerly direction from the east corner of the timber dock of the United States navy-yard, the pier-head line coincides with the bulkhead line of the Main Channel for a distance of 605 feet; thence runs northerly in a straight line to a point which is distant 385 feet easterly from the easterly side line of said avenue, measuring at right angles to said avenue from a point in the said easterly side line, which latter point is distant 100 feet southerly from the top face of the northerly abutment of said avenue, measuring said latter distance on said easterly side line; thence turning and running northwesterly in a straight line to a point in the easterly side line of said avenue extended northerly, which point is distant 65 feet northerly from the top face of the abutment aforesaid, measuring on said easterly side line so extended. Then beginning again at a point in the westerly side line of said avenue extended northerly, which point is distant 65 feet northerly from the top face of the abutment aforesaid, measuring on said westerly side line so extended; thence running westerly in a straight line to a point which is distant 30 feet northerly from the northwesterly angle of the sea-wall of said corporation as now built; thence turning a little and running still westerly in a straight line parallel to and 30 feet distant northerly from the top face of the northerly sea-wall of said corporation as the same is now authorized to be built, until the said straight line intersects the easterly side line of Elm street extended northeasterly; thence southerly along said line of Elm street to the bulkhead line.

Said pier-head line coincides with the line established by the State in chapter 272 of the acts of 1885.

The pier-head line on the north side of the South Channel is parallel to the bulkhead line and 35 feet outside of it, as established by the State in chapter 19 of the acts of 1859.

Chelsea side of Mystic River and Chelsea Creek, between Chelsea Bridge and Meridian Street Bridge—Pier and bulkhead lines.—The pier-head line coincides with the line established by the State in chapter 344 of the acts of 1887, and is as follows: Beginat a point on the southeasterly side of Chelsea Bridge at the southeasterly corner of the solid portion of said bridge, as now built, at the Chelsea end thereof; thence running southeasterly down Mystic River, making an angle of 73° 6′ taken from a southwesterly to a southeasterly direction with the southerly side of said bridge, and passing through the southwesterly corner of Black's Wharf, 697.57 feet to a point at or near the angle of junction of Chelsea Creek with Mystic River; thence turning 78° 58′ 11″ to the east and north and running northeasterly up Chelsea Creek, passing through the southeasterly corners of Gerrish's Wharf and Bisbee's Wharf, 1,496.03 feet to a point on the westerly side of Meridian Street Bridge, marked by an iron plate and copper tack, and distant 23.3 feet southerly from the abutment of said bridge at the Chelsea end thereof.

The bulkhead line is parallel to and 300 feet within the pier-head line.

North side of Mystic River, between Chelsea Bridge and Boston and Maine Railroad Bridge—Pier and bulkhead lines.—Beginning at a point where a line drawn on the north side of the channel parallel to and 1,200 feet distant from the bulkhead line on the south side of the channel intersects the westerly line of the north abutment of Chelsea Bridge, marked M on Boston Harbor Line Board Sheet "J," the pier-head line runs westerly in said parallel line 2,000 feet to a point marked N. Beginning again at a point marked O in said parallel line, at the point of its intersection with the easterly line of Elm street produced across the river and running westerly in said parallel

line 2,475 feet, to a point marked P; thence in the arc of a circle curving west and north, and tangent to said line at said point P, with a radius of 1,600 feet, to its intersection with the westerly line of the Malden Bridge abutment; thence northwesterly in a straight line to a point at the mouth of the Malden River marked Q, said point being 710 feet from the easterly side of the Boston and Maine Railroad Bridge, measuring at right angles thereto from a point 570 feet northerly of the south end of the north abutment of said bridge.

The bulkhead line is coincident with the pier-head line between the points M and N. Between Island End and Malden Rivers the bulkhead line is 600 feet within and parallel to the pier-head line, terminating in Island End River in the northeasterly line of Elm street produced northerly, and in Malden River in the line hereafter described for the left bank of that river.

The harbor lines upon the north side of the river, established by the State in chapter 293 of the acts of 1856, and chapter 302 of the acts of 1874, are indicated upon sheet J.

South side of Mystic River, above the Boston and Maine Railroad Bridge—Bulkhead and pier-head lines.—Beginning at the northeast corner of the south abutment of the Boston and Maine Railroad Bridge, the bulkhead and pier-head lines are coincident and follow the north face of said abutment to the west corner thereof; thence running southerly along the westerly face of the said abutment, a distance of 700 feet; thence continue northwesterly 1,200 feet on a line which if prolonged would pass through the northeasterly corner of the south abutment of the Middlesex Avenue Bridge; thence turning westerly through an angle of 135° measured from a southeasterly to a southwesterly direction, continue in a straight line for a distance of 300 feet; thence turning northwesterly continue in a straight line to the northeasterly corner of the south abutment of Middlesex Avenue Bridge; thence along the northerly face of said abutment to the northwest corner thereof; thence by an angle of 62° with the west face of Middlesex Avenue Bridge continue northwesterly in a straight line for a distance of 525 feet; thence by the arc of a circle with a radius of 510 feet tangent thereto measuring about 64° 30′ from an easterly to a westerly direction, and by a tangent which extended would strike the southerly line of Mystic avenue at a point 1,420 feet westerly of the southwest corner of Mystic avenue and Taylor street, to a point 250 feet northeasterly from the south side of Mystic avenue, measured along said tangent; thence northwesterly by a straight line making an angle of 40° with said tangent, to the line of the northerly side of Mystic avenue, at a point marked X.

North side of Mystic River, above Boston and Maine Railroad Bridge Bulkhead and pier-head lines.—Beginning at the easterly corner of the north abutment of the Boston and Maine Railroad Bridge, the bulkhead and pier-head lines are coincident and follow the southerly face of said abutment to the southwest cornef thereof; thence the westerly face of the said abutment for a distance of 400 feet; thence northwesterly by a straight line making an angle of 40° with said line and said abutment, a distance of 450 feet; thence northwesterly by a straight line which prolonged would strike the easterly side of Middlesex Avenue Bridge at a point 290 feet northerly of the end of the draw opening on the north side, a distance of 1,000 feet; thence northwesterly to a point in the westerly side of Middlesex Avenue Bridge 425 feet distant from the southwesterly end of the draw opening in the north side; thence turning westerly and southerly by the arc of a circle of 1,915 feet radius (the center of said circle being in the west face of Middlesex Avenue Bridge prolonged), through about 45°; thence southwesterly by a tangent to said arc which prolonged would strike the southerly side of Mystic Avenue prolonged at a point 1,725 feet westerly of the southwest corner of Mystic avenue and Taylor street to a point 560 feet from its intersection with the south side of Mystic avenue measured in said tangent; thence by the arc of a circle turning from a southeasterly to a southwesterly direction and tangent to said last tangent line with a radius of 340 feet to a line tangent thereto, and 275 feet distant from and parallel to Mystic avenue at a point marked Y.

Above the points X and Y the lines are coincident and follow the meanderings of the river with a variable distance apart as indicated upon Harbor Line Board Sheet L, to the Medford Street Bridge in the town of Medford.

The State has established no lines on the river above the Boston and Maine Railroad Bridge.

DESCRIPTION OF HARBOR LINES FOR MALDEN RIVER, BETWEEN THE MOUTH OF THE RIVER AND THE DAM IN MALDEN, WHICH ARE RECOMMENDED FOR THE APPROVAL AND ADOPTION OF THE SECRETARY OF WAR BY THE HARBOR LINE BOARD FOR BOSTON HARBOR, CONSTITUTED BY SPECIAL ORDER NO. 38, HEADQUARTERS CORPS OF ENGINEERS, AUGUST 13, 1888, IN ITS REPORT DATED MAY 23, 1890.

Malden River—Pierhead and bulkhead lines.—Beginning at the point Q in the pier-head line on the north side of Mystic River, the pier-head line runs in the arc of a

circle of a radius of 600 feet through 69°, turning in a northerly direction; thence by a tangent to this arc to an intersection with the bulkhead line on the north side of Mystic River prolonged northwesterly, which point is marked R.

Beginning again at the southeasterly corner of the north abutment of the Boston and Maine Railroad Bridge, the pier and bulkhead lines are coincident and follow the easterly side of said bridge abutment, a distance of 570 feet; thence in a straight line to a point easterly of and 170 feet distant from the easterly rail of the Boston and Maine Railroad measured at right angles thereto from a point on said rail 1,010 feet north of the south end of the north abutment of said railroad company's bridge; thence runs more easterly in a straight line to a point 460 feet distant from the easterly rail of the Boston and Maine Railroad, measured at right angles thereto from a point on said rail 1,355 feet north of the south end of the north abutment of said railroad company's bridge; thence runs still more easterly to a point 815 feet distant from the easterly rail of the Boston and Maine Railroad, measured at right angles thereto from a point on said rail 1,615 feet north of the south end of the north abutment of said railroad company's bridge, which point is marked S.

The distance between the points R and S is about 400 feet. Above these points the bulkhead lines follow the meanderings of the river and converge gradually to a distance apart of 150 feet opposite the switch of the Medford branch of the Boston and Maine Railroad; thence in a distance of about 600 feet they approach to 100 feet of each other and preserve this distance apart of 100 feet to a point about 200 feet below the second bridge near the rubber works; thence they converge to a distance apart of 50 feet at said bridge.

Above the points R and S, pile structures may be authorized to extend beyond the bulkhead lines to the line of mean low water.

The State has established no lines for this river.

DESCRIPTION OF HARBOR LINES FOR ISLAND END RIVER WHICH ARE RECOMMENDED FOR THE APPROVAL AND ADOPTION OF THE SECRETARY OF WAR BY THE HARBOR LINE BOARD OF BOSTON HARBOR, CONSTITUTED BY SPECIAL ORDER NO. 38, HEADQUARTERS CORPS OF ENGINEERS, AUGUST 13, 1888, IN ITS REPORT DATED MAY 23, 1890.

Island End River.—Pier-head and bulkhead lines.—Beginning at the point 0 in the pier-head line on the north side of Mystic River, the bulkhead line runs northerly in the line of the easterly side of Elm street produced across the Mystic River to its intersection with the bulkhead line at the point marked X on the north side of Mystic River; thence turning easterly by an angle of 10° measured from a northeasterly to an easterly direction from the line of Elm street produced, it continues straight till it intersects the line of the northeasterly side of Beachem street produced southeasterly at the point marked Y; thence in a straight line to the point marked Z, which point is 500 feet distant from the northwesterly face of the powder magazine on the opposite side of the river, measured in the line of the northeasterly side of the powder-magazine wharf.

Beginning again at the point N in the harbor line on the north side of Mystic River, the bulkhead line runs northwesterly at an angle of 125° with the line M-N, measured in a northerly and westerly direction, a distance of about 430 feet; thence turning at an angle of 119° measured from a southeasterly to a northeasterly direction, it continues northeasterly about 625 feet till it intersects a line drawn parallel to the line Y-Z on the opposite side of the river, from a point in the northerly side of the powder magazine wharf 100 feet distant from the westerly face of the powder magazine.

Above the powder-magazine wharf the bulkhead lines follow the meanderings of the river gradually converging to a distance apart of 300 feet just below the fork of the river; thence the lines preserve a distance apart of 200 feet in the main river up to the solid dike, and in the branch a distance apart of 100 feet up to the mill-dam.

The lines thus described are bulkhead lines between which no solid filling shall be hereafter permitted, but pile wharves may be authorized to extend to the mean low-water line.

The State has established no lines for this river.

DESCRIPTION OF THE PIER-HEAD AND BULKHEAD LINES FOR CHELSEA CREEK, WHICH ARE RECOMMENDED FOR THE APPROVAL AND ADOPTION OF THE SECRETARY OF WAR BY THE HARBOR LINE BOARD FOR BOSTON HARBOR, CONSTITUTED BY SPECIAL ORDER NO. 38, HEADQUARTERS CORPS OF ENGINEERS, AUGUST 13, 1888, IN ITS REPORT DATED MAY 23, 1890.

East Boston side of Chelsea Creek, between Meridian Street Bridge and Chelsea Street Bridge—Pier-head and bulkhead lines.—Beginning at the point A of the pier-head line in the westerly face of Meridian Street Bridge, adopted by the Secretary of War July

27, 1889, the pier-head line runs southeasterly to a point 945 feet northerly of Condor street measured on a line at right angles thereto from a point in the northerly line of said street 840 feet east of its intersection with the easterly line of Meridian street; thence continues southeasterly to the northwest corner of the Glendon Rolling Mills Wharf; thence southeasterly along the face of said wharf, to the northeast corner thereof; thence easterly about 460 feet to a point marked H, situated 814 feet from the northerly side of Eagle street, measuring northerly, and at right angles thereto, from a point in said side of said street 460 feet westerly, from the intersection therewith of the westerly side of Chelsea street; thence northeasterly about 415 feet to a point marked I, situate 685 feet from the westerly side of Chelsea street, measuring northwesterly, and at right angles thereto, from a point in said side of said street, 685 feet northerly from the intersection therewith of the northerly side of Eagle street; thence northeasterly again, about 1,015 feet, to a point marked K, on the west side of Chelsea Free Bridge said point being 158 feet northerly from the face of the south abutment of said bridge.

This line varies slightly from the line established by the State in chapter 204, acts of 1849, and delineated upon the chart.

The bulkhead line commences at the termination of the bulkhead line in the west face of Meridian Street Bridge, adopted by the Secretary of War, July 27, 1889, and runs northerly to a point in the west face of said Meridian Street Bridge, distant 515 feet from the north side of Condor street; thence easterly to a point 500 feet northerly of Condor street, measured on a line at right angles thereto from a point in the northerly line of said street 840 feet east of its intersection with the easterly line of Meridian street; thence continues southeasterly to the intersection of the northerly line of Condor street with the easterly line of Knox street; thence easterly in the line of the northerly side of Condor street produced easterly about 1,038 feet to the westerly face of the East Boston Gas Company's solid wharf; thence northeasterly about 640 feet to a point 275 feet northwesterly of the northwesterly side of Chelsea street, measured on a line at right angles thereto from a point 830 feet northeasterly from the intersection of said side of said street with the northerly side of Eagle street; thence northeasterly about 820 feet to a point 120 feet southeasterly from the face of the south abutment of the Chelsea Street Bridge, measured in the line of the southwesterly face of the bridge; thence to the point K in the pier-head line.

Chelsea side of Chelsea Creek, between Meridian Street Bridge and Chelsea Street Bridge.—Pier-head and bulkhead lines.—The pier-head line coincides with the line established by the State in chapter 204 of the acts of 1849, with a slight variation near its termination in Meridian Street Bridge, and is as follows:

Commencing at a point on the west side of Chelsea Free Bridge, situated 202 feet southerly from the intersection of the same with the southerly line of Marginal street, in the town of Chelsea, said point being marked L on the plan; thence running southwesterly about 955 feet to a point marked M, situate 306 feet from the south line of Marginal street, measuring southerly and at right angles thereto, from a point in said side of said street, 15 feet easterly from the first bend therein, west of Chelsea Free Bridge, aforesaid; thence again, southwesterly, about 317 feet to a point marked N, situate 394 feet from the southerly side of Marginal street, measuring southerly and at right angles thereto, from a point in said side of said street 60 feet westerly from the afore-mentioned bend therein; thence westerly, about 386 feet, to a point marked O, situate 455 feet from the southerly side of Marginal street, measuring southerly, and at right angles thereto, from a point in said side of said street, 440 feet westerly from the afore-mentioned bend therein; thence again, westerly, about 210 feet to a point marked P, being the southwesterly corner of the Glendon Rolling Mills Company's pier on the Chelsea Flats, situate in the division line of the Winnisimmet Company's water lots, numbered 21 and 22, and 465 feet from the southerly side of Marginal street, measuring southerly and at right angles thereto; thence again, westerly, about 1,330 feet to a point marked Q, situate in the division line between Austin and Carruth's wharves, and 248 feet from the southerly side of Marginal street, measuring southerly and at right angles thereto; thence again, westerly, about 740 feet to a point marked R, situate in the line of the southerly side of Hawes' Wharf continued and 300 feet from the southerly side of Marginal street, measuring southerly and at right angles thereto; thence again, westerly, about 640 feet to a point in the westerly side of Meridian Street Bridge marked by an iron plate and copper tack, and distant 23.3 feet southerly from the abutment of said bridge at the Chelsea end thereof.

The bulkhead line is in rear of the pier-head line and follows the southeasterly side of Marginal street, from Chelsea street to the corner of Pearl and Williams streets.

Chelsea side of Chelsea Creek, above Chelsea Street Bridge.—Pier-head and bulkhead lines.—Beginning at a point in the easterly side of Eastern avenue, at its intersection with the stone wharf on the southerly side of Bass Creek, the pier-head line follows the northerly face of said stone wharf and its prolongation easterly for a distance of 560 feet; thence by an arc of a circle of 400 feet radius, turning easterly

and southerly and by a tangent to said arc, to the point L of the pier-head line in the westerly face of Chelsea Street Bridge, previously described.

Beginning again at the point in the easterly side of Eastern avenue, above described, the pier-head line follows the easterly side of said avenue northerly a distance of 80 feet; thence turns easterly and runs parallel to the line on the southerly side of Bass Creek till it intersects with the westerly side of Marginal street; thence turning easterly and northerly by the arc of a circle of 530 feet and a tangent thereto to a point in the south side of Willoughby street extended easterly 530 feet from the southwest corner of Willoughby and Marginal streets; thence to a point in the north side of Dana street extended easterly 800 feet from the east side of Marginal street; thence to a point in the north side of Bancroft street extended easterly 900 feet from the east side of Marginal street; thence to a point 580 feet southeasterly from the east side of the abutment of the Eastern Railroad Bridge over Chelsea Creek, measuring in a line perpendicular thereto, at a point 50 feet southwest from the northeast corner of said abutment; thence by the arc of a circle of 200 feet radius, turning northerly and westerly through an angle of about 141°; thence in a tangent to said circle to the point 50 feet southwest of the abutment above referred to; thence to the northeast corner of said abutment; thence along the face of the abutment to the northwest corner; thence in a straight line, making an angle of 65 degrees with the western face of said abutment, to the dam of Slade's tide-mill.

Bulkhead line.—Beginning at the intersection of the south side of Marginal street with the west side of Chelsea Street Bridge, the line follows the southerly side of said Marginal street and its prolongation northeasterly to the easterly side of the Grand Junction Railroad Bridge; thence northeasterly by line parallel to the pier-head line about 970 feet, and by an arc of a circle of 325 feet radius, turning westerly to an intersection with the pier-head line on the south side of Bass Creek; thence it is coincident with the pier-head line to and along the easterly side of Eastern avenue and the northerly side of Bass Creek to the west side of Marginal street; thence the bulkhead line turns easterly and northerly by the arc of a circle of 315 feet radius and a tangent thereto to a point in the side of Willoughby street produced easterly, distant 210 feet from the west side of Marginal street; thence by a straight line to the north side of Dana street 470 feet easterly from the east side of Marginal street; thence to a point in the south side of Louis street 615 feet easterly from the east side of Marginal street; thence follows the southerly side of Louis street prolonged to its intersection with the pier-head line; thence the bulkhead line is coincident with the pier-head line to Slade's mill-dam.

Easterly side of Chelsea Creek, above Chelsea Street Bridge.—Pier-head and bulkhead lines.—Beginning at the point K of the pier-head line in the westerly side of Chelsea Street Bridge, before described, the pier-head and bulkhead lines are coincident, and follow the high-water lines and the westerly side of the railroad embankment and trestle to Slade's mill-dam, as delineated on the chart.

d. EXTENSION OF PIER AT MARINE PARK BEYOND ESTABLISHED HARBOR LINES, DORCHESTER POINT, EASTERN END OF SOUTH BOSTON.

UNITED STATES HARBOR-LINE BOARD,
Boston, Mass., January 30, 1890.

GENERAL: The Harbor-Line Board for Boston Harbor, constituted by Special Orders No. 38, Headquarters Corps of Engineers, August 13, 1888, has the honor to state that at a session held in this city June 25, 1889, it submitted to the Secretary of War for approval, in a report dated July 20, 1889, the State pier-head and bulkhead line across the eastern end of South Boston at Dorchester Point, which line, marked A to C, was approved by the Secretary of War July 27, 1889.

At the time the report was submitted the park commissioners of the city of Boston, under authority of State law, were building an iron pier with solid abutment out into the harbor in advance of the State harbor-lines.

In a letter dated January 28, 1890, the park commissioners made an application to the Board that certain changes be made in the approved harbor lines adjacent to the iron pier, to conform to plans prepared by them in connection with the Marine Park, of which the iron pier is an *important* feature.

The Board does not favor any change in the harbor lines approved by the Secretary of War July 27, 1889, but in view of the fact that the park commissioners had been authorized by the legislature of Massachusetts to extend their structures beyond the State harbor line, subsequently adopted by the Secretary of War, and that the pier in question has been nearly completed, the Board respectfully recommends that the Secretary of War authorize the park commissioners to extend it as far as shown upon the inclosed chart.

Respectfully submitted,

HENRY L. ABBOT,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.
G. L. GILLESPIE,
Lieut. Colonel of Engineers.
S. M. MANSFIELD,
Lieut. Colonel of Engineers.
W. R. LIVERMORE,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
February 3, 1890.

Respectfully submitted to the Secretary of War.

In a report dated July 20, 1889, the Harbor-Line Board for Boston Harbor submitted for approval the State pier-head and bulkhead line across the eastern end of South Boston at Dorchester Point, which line was approved by the Secretary of War July 27, 1889.

It appears that at the time the report was submitted the park commissioners of the city of Boston, under authority of State law, were building an iron pier out into the harbor in advance of the State harbor-lines, and they have requested of the Harbor-Line Board that certain changes be made in the approved harbor lines adjacent to the iron pier, to conform to plans prepared by them in connection with the Marine Park, of which the iron pier is an important feature.

The Board does not favor any change in the harbor lines already approved, but recommends, in view of the fact that the park commissioners had been authorized by the legislature of Massachusetts to extend their structure beyond the lines subsequently adopted, and that the pier in question has been nearly completed, that the Secretary of War authorize the park commissioners to extend it as far as shown upon the inclosed chart.

The views and recommendations of the Board are concurred in by me.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[The chart showing the pier extension desired by the park commissioners was approved by the Secretary of War February 4, 1890.]

e. EXTENSION OF SOLID FILLING, BEYOND THE ESTABLISHED BULKHEAD LINES, AT SIMPSON'S DRY DOCK, NO. 1, BOSTON HARBOR.

BOSTON, *April* 16, 1890.

The Simpson Dry Dock Company, of Boston, Mass., respectfully represents that it is the owner of three dry docks bounding on Marginal

street in East Boston; that the westerly and larger of said dry docks (marked Dry Dock No. 1 upon the plan filed herewith) is 365 feet long, and when built was capable of receiving the largest vessels which were then accustomed to come into Boston Harbor; that by reason of the increase in size of many of the vessels running regularly into the port of Boston, said dry dock is no longer large enough to receive many of said vessels in case they are in need of repairs, and that there is in Boston Harbor no dry dock besides those of said company of any considerable size.

Said company further represents that it is desirous of enlarging its said dry dock, and that in order to do so it will be necessary for it to extend the existing solid filling on either side thereof in a southerly direction, and that the present solid filling is already south of the bulkhead line established as the line beyond which no solid filling is in the future allowed, except with the permission of the Secretary of War; that if the company is allowed to extend said solid filling in a southerly direction, as herein requested, it will, when completed, be some 65 or more feet within and northerly of the harbor-line to which pile structures may be built.

Said Simpson Dry Dock Company, therefore, respectfully requests that it may be authorized by the Secretary of War to extend the present solid filling on either side of its westerly dry dock (marked Dry Dock No. 1 on said plan) in a southerly direction for a distance not exceeding 100 feet, the spaces so to be filled not to exceed 40 feet in width.

The spaces which the company desires to fill solidly are shown on the plan which is filed herewith, and are indicated in red.

SIMPSON'S P. DRY DOCK COMPANY,
By EDWARD WHITNEY, *President.*
NATHAN CROWELL, *Treasurer.*

To the Honorable REDFIELD PROCTOR,
Secretary of War.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
April 19, 1890.

Respectfully referred to the Board of Engineers, constituted by orders from this office to consider the matter of the harbor-lines of the port of Boston, Mass., for report.

By command of Brig. Gen. Casey.

H. M. ADAMS,
Major Corps of Engineers.

[Third indorsement.]

U. S. HARBOR-LINE BOARD,
Boston, Mass., April 22, 1890.

Respectfully returned to the Chief of Engineers, U. S. Army.

The Harbor-Line Board, at its session to-day, considered the within matter and recommend that authority be granted the Simpson Patent Dry Dock Company to extend the solid filling of its Dock No. 1, in accordance with the application and the accompanying tracing.

HENRY L. ABBOT,
Colonel of Engineers,
Bvt. Brig. Gen. U. S. A.,
President of the *Board.*

[Fourth indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
April 24, 1890.

Respectfully returned to the Secretary of War.

The Simpson Dry Dock Company, of Boston, Mass., requests permission to extend the present solid filling on either side of its westerly dry dock (marked Dock No. 1 on accompanying tracing) in a southerly direction for a distance not exceeding 100 feet.

This application was referred to the Harbor-Line Board for Boston Harbor, and its favorable report is given in the third indorsement.

I concur in the views of the Board.

THOS. LINCOLN CASEY,
Brig. Gen. Chief of Engineers.

[Fifth indorsement.]

WAR DEPARTMENT,
April 26, 1890.

The recommendation of the Harbor-Line Board, as concurred in by the Chief of Engineers, is approved.

REDFIELD PROCTOR.
Secretary of War.

LETTER OF A. W. BEARD, COLLECTOR OF THE PORT OF BOSTON.

BOSTON, MASS., *April* 16, 1890.

DEAR SIR: The Simpson Dry Dock Company have shown me their petition asking for leave to extend the solid filling of their dock, in order to increase the size of the same. There is no d y dock of any considerable size in Boston except those belonging to the Simpson Dry Dock Company, and their largest one is too small to accommodate many of the steam-ships belonging to the trans-Atlantic lines running to this port. It seems to me extremely desirable that there should be here some dry dock of sufficient size for that purpose, and I therefore deem it for the interests of the port and recommend that the petition of the company be granted.

Yours, respectfully,

A. W. BEARD,
Collector of the Port.

To the Hon. REDFIELD PROCTOR,
Secretary of War.

LETTER OF THE HARBOR AND LAND COMMISSIONERS OF MASSACHUSETTS.

HARBOR AND LAND COMMISSIONERS' OFFICE,
Boston, April 17, 1890.

The application of the Simpson Patent Dry Dock Company, with accompanying plan (both of which are dated April 16, 1890), for permission to extend the solid piers on each side of its Dry Dock No, 1, as shown in red on said plan, have been submitted to, and have the approval of this Board.

No additional obstruction would be caused thereby to the general navigation of the harbor, and the displacement by solid filling is inconsiderable as compared with the advantage to commerce of having a dry dock large enough to receive the longest steamers and vessels coming to the harbor of Boston.

Respectfully submitted.

JOHN E. SANFORD,
JOHN I. BAKER,
CHAS. H. HOWLAND,
Harbor and Land Commissioners.

To the Honorable the SECRETARY OF WAR.

APPENDIX C.

IMPROVEMENT OF HARBORS AND RIVERS ON THE SOUTHERN COAST OF MASSACHUSETTS AND IN RHODE ISLAND AND CONNECTICUT.

REPORT OF MAJOR WILLIAM R. LIVERMORE, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1890, *WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. Harbor of Refuge at Hyannis, Massachusetts.
2. Harbor of Refuge at Nantucket, Massachusetts.
3. Vineyard Haven Harbor, Massachusetts.
4. Wareham Harbor, Massachusetts.
5. New Bedford Harbor, Massachusetts.
6. Taunton River, Massachusetts.
7. Warren River, Rhode Island.
8. Pawtucket River, Rhode Island.
9. Providence River and Narragansett Bay, Rhode Island.
10. Removal of Green Jacket Shoal, Providence Harbor, Rhode Island.
11. Newport Harbor, Rhode Island.
12. Harbor of Refuge at Block Island. Rhode Island.
13. Pawcatuck River, Rhode Island and Connecticut.
14. Harbor of Refuge at Stonington, Connecticut.
15. Removing sunken vessels or craft obstructing or endangering navigation.

EXAMINATIONS AND SURVEYS.

16. Martha's Vineyard, inner and outer harbor at Edgartown, Massachusetts.
17. Cove near southeast extremity of Coaster's Harbor Island, Rhode Island.
18. Coast near life-saving station, East Point Judith, Rhode Island.
19. Narragansett Bay at the mouth of Narrow River, Rhode Island.

ENGINEER OFFICE, U. S. ARMY,
Newport, R. I., July 1, 1890.

GENERAL: I have the honor to submit herewith annual reports for the year ending June 30, 1890, for river and harbor works in my charge.

This office was assisted during the year by Assistant Engineer Edward Parrish and Assistant Engineer John H. Rostock, and by Assistant Engineer Walter C. Simmons from August 13, 1889.

Very respectfully, your obedient servant,

W. R. LIVERMORE,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. Army.

C 1.

HARBOR OF REFUGE AT HYANNIS, MASSACHUSETTS.

The harbor of Hyannis lies on the south shore of the peninsula of Cape Cod, about 15 miles to the westward of the heel of the cape, and is an important harbor of refuge.

The mean rise and fall of the tide is about 3¾ feet.

ORIGINAL CONDITION.

Before improvement it was an open roadstead, exposed to southerly storms.

PLANS OF IMPROVEMENT.

In the years 1827–1838 a breakwater of riprap granite, 1,170 feet long, was constructed, covering an anchorage of about 175 acres, the entrance to which had a depth of about 15½ feet. In the years 1852–1882 extensive repairs were made in increasing the width of its base and the size of the stone forming its sides and top.

The depth of water immediately inside the breakwater being insufficient for many vessels that seek the harbor of refuge, the present project for the improvement of the harbor published in the Report of the Chief of Engineers for 1885, volume 1, pages 560 and 619–621, contemplates dredging the area protected by the breakwater to a depth of 15½ feet at mean low water.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1889.

The amount expended on this work up to June 30, 1889, was $129,395.81. The breakwater had been completed according to the original project and the subsequent plans for strengthening it, and the 15½ foot anchorage area had been increased by about 6.9 acres.

OPERATIONS DURING THE LAST FISCAL YEAR.

At the beginning of the last fiscal year no work was in progress. On account of the exposed position of the dumping ground it has not been the practice to attempt any work of dredging in this harbor except during the summer season. During the summer of 1889 no plant could be obtained for this work; the work, however, is now in progress, with the dredge *Texas*, tug *Gen. Warren*, and two scows, all belonging to the Government.

AMOUNT EXPENDED DURING THE LAST FISCAL YEAR AND RESULTS TO JUNE 30, 1890.

The amount expended during the last fiscal year including liabilities outstanding June 30, 1890, was $12,045.77 and the result was the commencement of the work of dredging in the 15½-foot anchorage area protected by the breakwater, and the purchase of dredging plant to the value of $9,937.30.

WORK REQUIRED TO COMPLETE THE EXISTING PROJECT.

The work required to complete the existing project is the completion of the dredging to a depth of 15½ feet in the area limited on the west by

a line running due north from the western end of the breakwater, and on the north by a line running parallel to the breakwater, and distant 1,500 feet from it, leaving a berm of 100 feet along its northern side.

OPERATIONS CONTEMPLATED FOR THE FISCAL YEAR ENDING JUNE 30, 1891.

The execution of the project above referred to, of deepening the anchorage area inside the breakwater, will be continued.

Hyannis Harbor is in the Barnstable collection district, and Barnstable is the nearest port of entry. The amount of revenue collected at Barnstable in the last fiscal year was $1,139.34.

The main value of the harbor is for a harbor of refuge. The nearest light-house is Hyannis Light; the nearest fortification is the fort at Clark's Point, New Bedford, Mass.

Money statement.

July 1, 1889, amount available		$13,961.77
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$10,439.82	
July 1, outstanding liabilities	1,605.95	
		12,045.77
July 1, 1890, balance available		1,916.00
Amount appropriated by act of September 19, 1890		8,000.00
Amount available for fiscal year ending June 30, 1891		9,916.00
Amount (estimated) required for completion of existing project		17,662.00
Amount that can be profitably expended in fiscal year ending June 30, 1892		17,662.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

COMMERCIAL STATISTICS.

[Furnished by Mr. A. F. Lothrop, Hyannis, Mass.]

Articles.	1888.	1889.
Imports:	*Tons.*	*Tons.*
Coal	16,000	14,000
Grain	3,000	3,300
Lumber	1,951	1,625
Lime	38	38
Fish	100	100
Merchandise	100	.....
Exports:		
Merchandise, including fish, cedar posts, rails, etc	300	.....

Vessels in harbor.

	1888.	1889.
Sailing	1,600	1,734
Steam	150	275

C 2.

HARBOR OF REFUGE AT NANTUCKET, MASSACHUSETTS.

Nantucket Harbor is the only one between the harbors of Martha's Vineyard (Vineyard Haven and Edgartown) and Provincetown, a distance of about 100 miles, except the small harbor of Hyannis, on the other (the north) side of Nantucket Sound. The navigation of this sound is intricate and dangerous by reason of numerous shoals. Nantucket Harbor has deep water inside, and the object of the improvement is to make it a harbor of refuge for vessels plying between ports north and south of Cape Cod, estimated to be 30,000 annually. In the memorial to Congress, on which the first appropriation for this harbor of refuge was based, it was stated that more than 500 vessels had been wrecked in the vicinity of the island.

The mean rise and fall of the tide is about 3 feet.

ORIGINAL CONDITION.

Before the commencement of the present work there was a shoal about 1½ miles in width outside the entrance, through which shoal the channel or line of best water was only about 6 feet deep and very crooked and subject to changes in location.

PLAN OF THE WORKS.

The present approved project is to construct jetties of riprap stone projecting from either side of the present entrance to the harbor, for the purpose of concentrating the strength of the tidal currents, and excavating a channel of 15 feet depth by scour, and at the places where the full depth required will not be reached by this means to complete the work by dredging. A plan of the works may be found in the Report of the Chief of Engineers for 1885, vol. 1, page 578.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1889.

The amount expended on this project up to the close of the fiscal year ending June 30, 1889, was $141,803.77, and the result was the construction of the west jetty to a point 3,955 feet from the shore and the east jetty to a distance of 400 feet from its initial point on shore, which is the outer end of the middle of the three northwest spurs built on Coatue Beach some years ago, and the foundation was laid and the jetty partially completed for an additional distance of 200 feet.

OPERATIONS DURING THE LAST FISCAL YEAR.

At the beginning of the last fiscal year work under the contract with James Scully, of Groton, Conn., dated February 8, 1889, for placing stone in the east jetty, was in progress and was continued until November 6, 1889. The amount of stone placed in the eastern jetty under this contract during the fiscal year was 6,055 tons, or a total under the contract of 6,728 tons.

Mr. C. O. Abell was the local inspector of the work under this contract.

Under date of November 13, 1889, supplemental articles of agreement were entered into with Mr. Scully, providing that the contractor be relieved from placing any more stone in the jetty in consideration of his selling to the Government at a reduced price on the wharf at Nantucket the remainder of the stone he had taken there. This stone, amounting

to 830 tons, has been received and placed on the jetty with plant belonging to the United States.

A survey was made in November, 1889, by Mr. C. O. Abell, the local inspector of the work, which showed a channel 7½ feet deep at mean low water between the jetties.

In May, 1890, it was reported that the steam-boat running to Nantucket had difficulty in entering the harbor on account of the shoaling of the channel. Another survey was made in June, 1890, by Mr. W. C. Simmons, assistant engineer, which showed that the 7½-foot channel still existed, but that it was to the eastward of the course followed by the steam-boats, and in about the same position as that shown by the November survey.

AMOUNT EXPENDED DURING THE LAST FISCAL YEAR, AND RESULTS TO JUNE 30, 1890.

The amount expended during the last fiscal year, including outstanding liabilities to June 30, 1890, was $3,147.53, and the result was the completion of the eastern jetty to a distance of 834 feet from the initial point on shore, and its partial construction for an additional distance of 191 feet, and the purchase of plant to the value of $3,045.99.

WORK REQUIRED TO COMPLETE THE EXISTING PROJECT.

The work required to complete the existing project is the completion of the east and west jetties, and the excavation by dredging of so much of the channel as may not be excavated by tidal scour.

OPERATIONS CONTEMPLATED FOR THE FISCAL YEAR ENDING JUNE 30, 1891.

It is proposed to continue the costruction of the eastern jetty as far as the available funds will permit. The cost of constructing this jetty has been more than doubled from the fact that the appropriations have been so small that only short sections could be built each year. The currents wash away the sand around the head of the jetty, so that it becomes necessary to lay the foundation in 12 or 14 feet of water instead of 4 or 5 feet. For this reason an appropriation of $100,000 is asked for, instead of $50,000 as heretofore.

Nantucket is in the Nantucket collection district, and is a port of entry. There was no revenue collected in the last fiscal year. The value of the harbor is mainly as a harbor of refuge. The nearest light-houses are Nantucket Cliff and Brant Point lights. The nearest fortification is the fort at Clark's Point, New Bedford, Mass.

Money statement.

July 1, 1889, amount available		$3,196.23
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$2,664.42	
July 1, 1890, outstanding liabilities	483.11	
		3,147.53
July 1, 1890, balance available		48.70
Amount appropriated by act of September 19, 1890		25,000.00
Amount available for fiscal year ending June 30, 1891		25,048.70
Amount (estimated) required for completion of existing project		205,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892		100,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

[Furnished by Mr. Joseph W. Clapp, collector of customs, Nantucket, Mass.]

Receipts by water.

Articles.	1888.	1889.	Articles.	1888.	1889.
	Tons.	*Tons.*		*Tons.*	*Tons.*
Coal	9,250	11,400	Lime	120	150
Grain	120	180	Cement	53	75
Flour	25	27	Wood	350	400
Hay	230	180	Salt	23	30
Lumber	1,951	2,601	Railroad sleepers	120	125
Brick	400	600	General merchandise	4,000	5,000

Vessels in harbor.

	1888.	1889.
Sailing	213	270
Steam	17	20

C 3.

IMPROVEMENT OF VINEYARD HAVEN HARBOR, MASSACHUSETTS.

Vineyard Haven is a deep indentation in the northern shore of the island of Martha's Vineyard, on the southern side of Vineyard Sound. It is triangular in form and faces the northeast. The width of the mouth of the harbor, or the distance between the points of land on the east and west sides of the entrance known as East Chop and West Chop, is about 1¼ miles, and from a line connecting the chops to the narrow southerly end of the harbor, at which is situated the town of Vineyard Haven, the distance is about 1¾ miles. The entire area of the harbor between the shore-lines is about 949 acres, of which some 657 acres have a depth of not less than 15 feet. The mean rise and fall of the tide is 1.7 feet.

At the mouth of the harbor the wearing away of the chops by the action of the waves in storms has been noted for many years. The former sight of a light-house on West Chop has entirely disappeared. The débris is carried by the current into the harbor, where it forms shoals which are gradually impairing the anchorage capacity, especially in the upper part of the harbor.

PLAN OF IMPROVEMENT.

The plan of improvement contemplates the protection of the chops from the action of the storm waves, by the construction of jetties and other works along the shore.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1889.

The amount expended on this project up to the close of the fiscal year ending June 30, 1889, including outstanding liabilities, was $3,922.72, and the result was the temporary wharf at West Chop, for the landing of material for the experimental jetties, was partially built, and 253 tons of stone were placed in two of the jetties.

OPERATIONS DURING THE LAST FISCAL YEAR.

At the beginning of the last fiscal year work was in progress on a temporary wharf at West Chop on which the material for the experimental jetties was to be landed. This wharf and three jetties have been completed. They extend from the foot of the bluff out to about 4 feet of water at mean low water, a distance of from 80 to 150 feet, and are 200 feet apart. Two of these jetties were built last fall, the space between them rapidly filled with sand and the shore-line was extended an average distance of 20 feet into the water. The improvement in the beach has been maintained.

Work of a similar character is now in progress at the East Chop.

Of the 840 tons of stone delivered at Vineyard Haven during the fiscal year, 375 tons were from Mason's Island Quarry, which is operated by the Government, and the remainder was purchased in the open market.

Mr. A. R. Elliot was the local superintendent of the work.

AMOUNT EXPENDED DURING THE LAST FISCAL YEAR AND RESULTS TO JUNE 30, 1890.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1890, was $19,416.28, and the result was the construction of a temporary wharf and three jetties 150 feet, 80 feet, and 100 feet long, respectively, on the West Chop, and the purchase of plant to the value of $8,938.26.

WORK REQUIRED TO COMPLETE THE EXISTING PROJECT.

The work required to complete the existing project is to continue the protection of the chops from the action of storm waves so far as may be necessary to prevent the sand from washing into the harbor.

OPERATIONS CONTEMPLATED FOR THE FISCAL YEAR ENDING JUNE 30, 1891.

The operations contemplated for the fiscal year ending June 30, 1891, are to continue the work of protection beginning at the East Chop.

Vineyard Haven is in the Edgartown collection district. Edgartown is the nearest port of entry. The amount of revenue collected at Edgartown in the last fiscal year was $310.94. The nearest light-houses are those on East and West Chops. The nearest fortification is fort at Clark's Point, New Bedford, Mass.

Money statement.

July 1, 1889, amount available		$21,077.28
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$15,718.23	
July 1, 1890, outstanding liabilities	3,698.05	
		19,416.28
July 1, 1890, balance available		1,661.00
Amount appropriated by act of September 19, 1890		10,000.00
Amount available for fiscal year ending June 30, 1891		11,661.00
Amount (estimated) required for completion of existing project		25,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892, Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		25,000.00

COMMERCIAL STATISTICS.

[Furnished by Mr. E. C. Lord, Vineyard Haven, Mass.]

Receipts.

Articles.	1888.	1889.
	Tons.	*Tons.*
Coal	6,500	6,000
Grain	120	1,310
Lumber	1,300	1,000
Iron		300
General merchandise	4,500	1,500

C 4.

IMPROVEMENT OF WAREHAM HARBOR, MASSACHUSETTS.

This harbor is an estuary at the head of Buzzard's Bay. The object of the improvement is to deepen and widen the channel leading from Buzzard's Bay to Wareham, the industries of which, and of several towns in the vicinity with which it is connected by rail, are chiefly the manufactures of iron, and depend largely on transportation by water of the material used therein. The commerce of Wareham is carried on in sailing vessels, and the channel is to be made a beating channel for such vessels.

Another object of the improvement is the raising of Long Beach, over which the sands from the bay were washed into the harbor. The mean rise and fall of the tide is 4 feet.

ORIGINAL CONDITION.

Before improvement the ruling depth in the harbor was about 7 feet at mean low water in a narrow and very crooked channel. Long Beach, a narrow sand-spit at the mouth of the harbor, was washed and abraded by the waves and currents at high water, and the material was carried into and shoaled the channel inside.

PLANS OF IMPROVEMENT.

The original approved project of 1871 for the improvement, and its subsequent modifications, provide for a channel 250 feet wide and 10 feet deep at mean low water from Barney's Point down to the entrance to the harbor. Above Barney's Point the width of the channel is to be 350 feet, with the same depth, 10 feet, as below that point. The plan includes also the raising and strengthening of Long Beach, of which a large portion was submerged at low water, to carry it above the storm-waves and currents and to hold it there, in order to prevent the filling of the improved channel above by material abraded from the beach.

A plat of Wareham Harbor, showing the lines of the channel now being excavated, may be found in the Annual Report of the Chief of Engineers for 1885, vol. 1, page 586.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1889.

The total amount expended on the improvement up to the close of the fiscal year ending June 30, 1889, including liabilities outstanding at that

date, was $73,047.20, and the result was that the channel in the upper part of the harbor in front of the wharves was carried to its full width and completed, and the eastern half of the second and third reaches below the wharves and about two-thirds of the eastern half of the fourth reach, which extends to Barney's Point, were excavated to the full depth of 10 feet below mean low water. Long Beach had been raised above high-water storm-tides, so that the wash of sand into the improved channel inside the beach had been stopped.

The channel for about one-half its width from Barney's Point to Wareham had been deepened to 10 feet, and a ruling depth of the approaches to Wareham had been increased from 7 to 9 feet, and the channel greatly widened in all the reaches.

Vessels of larger draught can be carried to Wareham than formerly. The increase in width of channel was a great help to all vessels in beating in and out of the harbor.

OPERATIONS DURING THE LAST FISCAL YEAR.

At the beginning of the last fiscal year no work was in progress. November 23, 1889, two dredges, hired of Henry Du Bois's Sons, of New York, were transferred from New Bedford, and dredging continued until December 7, 1889, when the plant was withdrawn by the owners, for fear it would be frozen in and have to remain there idle all winter. March 10, 1890, work was resumed by the dredge *Rhode Island*, owned by the United States. The dredging was confined to the Middle Ground, which was a shoal in mid-channel of Reach No. 9. Work was discontinued March 28, 1890.

AMOUNT EXPENDED DURING THE LAST FISCAL YEAR AND RESULTS TO JUNE 30, 1890.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1890, was $10,921.43, and the result was the completion of the southern half of Reach No. 8 to a width of 175 feet and depth of 10 feet, the removal of the Middle Ground, and the purchase of plant to the value of $3,690.36.

WORK REQUIRED TO COMPLETE THE EXISTING PROJECT.

The work required to complete the existing project is the excavation of the channel to its full width and depth down to the deep water above Long Beach, and the further building up of Long Beach by the construction of sand fences.

OPERATIONS CONTEMPLATED FOR THE FISCAL YEAR ENDING JUNE 30, 1890.

If an appropriation is made for this work the funds will be applied to the completion of the channel and to the further building up of Long Beach.

Wareham is in the New Bedford collection district. New Bedford is the nearest port of entry. The amount of revenue collected at New Bedford in the last fiscal year was $109,675.30. The nearest light-houses are Bird's Island and Wing's Neck lights. The nearest fortification is the fort at Clark's Point, New Bedford, Mass.

Money statement.

July 1, 1889, amount available		$10,952.90
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$10,807.51	
July 1, 1890, outstanding liabilities	113.92	
		10,921.43
July 1, 1890, balance available		31.47
Amount appropriated by act of September 19, 1890		5,000.00
Amount available for fiscal year ending June 30, 1891		5,031.47
Amount (estimated) required for completion of existing project		7,236.00
Amount that can be profitably expended in fiscal year ending June 30, 1892		7,236.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

[Furnished by Mr. Alden Besse, Wareham, Mass.]

Received and shipped, 1889.

	Tons.
Coal	22,342
Flour	49
Grain	767
Iron	10,424
Lumber	1,495
Nails	625
Sand	9,727
Oyster-shells	1,600
Sundry articles used in manufacture of iron and steel	60

Number of arrivals at this port, 1889.

Schooners	189
Barges	20
Steam-tugs	50
Draught of largest vessels ... feet	12½
Number of tons	102,000

C 5.

IMPROVEMENT OF NEW BEDFORD HARBOR, MASSACHUSETTS.

New Bedford Harbor is an estuary of Buzzard's Bay, and is the port of the cities of New Bedford and Fairhaven, Mass. New Bedford is an important port of entry. It is largely interested in manufactures, those of cotton predominating, and has an extensive commerce in addition to its whale fisheries. The population of New Bedford and Fairhaven in 1888 was about 38,000.

The object of the improvement is to provide a channel 18 feet deep at mean low water.

The mean rise and fall of the tide is about 3 feet.

ORIGINAL CONDITION.

Before improvement the channel had a ruling depth of about 12½ feet at mean low water.

PLANS OF IMPROVEMENT.

As early as 1839 some little dredging was done for the improvement of the harbor. The increase of depth obtained, however, was only 2 feet, and the cut but 30 feet wide. A survey of the harbor was made in 1852, but a definite project for its improvement was not made until 1874. The project provided for a channel 200 feet wide and 15 feet deep at mean low water from the deep water just above Palmer's Island to the wharves at New Bedford. This project was modified in 1877, increasing the width of channel to 300 feet, and by means of appropriations made in 1875–'76, amounting to $20,000, the project was completed in 1877. Since that time vessels of larger draught have been employed in the harbor, and vessels of 15 feet draught not only now touch the bottom in this channel, but in the channel below Palmer's Island, which was not included in the former improvement. There is not sufficient water for the commerce of the port.

The project under which work is now carried on was adopted in 1888. It provides for the excavation of a channel 200 feet wide and 18 feet deep at mean low water extending from Butler's Flat to the vicinity of the wharves at New Bedford. A plat of the proposed improvement was published in House Ex. Doc. No. 86, Fiftieth Congress, first session.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1889.

The amount expended to June 30, 1889, including outstanding liabilities at that date was $20,991. The result was the excavation of the channel under the original project and its modifications to a width of 300 feet and a depth of 15 feet at mean low water.

OPERATIONS DURING THE LAST FISCAL YEAR.

At the beginning of the last fiscal year no work was in progress. On the 11th of November, 1889, two dredges hired of Henry Du Bois' Sons, of New York, which had been working in Providence River and on Green Jacket Shoal, and one hired of Brainard Bros., of New York, which had been working on Pawtucket River, were transferred to New Bedford and commenced work on November 18. In addition to these dredges the dredge *Texas*, belonging to the United States, was also at work in the harbor. Three of these dredges worked on the southern half of the channel extending from the deep water at the upper end of Palmer's Island to the vicinity of the wharves in New Bedford, and the fourth was engaged in removing the shoal spots in the western half of the channel extending from the 11-foot bank below Palmer's Island to the deep water at the upper end of the island.

During the portions of the months of November and December in which the work was carried on 40,700 cubic yards of material were excavated from the new channel; 2,965 cubic yards were also excavated in February, 1890. The work was carried on under the local supervision of Mr. W. C. Simmons, assistant engineer.

AMOUNT EXPENDED DURING THE LAST FISCAL YEAR AND RESULTS TO JUNE 30, 1890.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1890, was $8,975.02, and the result was the excavation of a channel to a depth of 18 feet at mean low water and a width

of 100 feet, requiring the excavation of 43,665 cubic yards of mud, sand, and gravel from the deep water of Buzzard's Bay, near the 11-foot bank, to the vicinity of the wharves in New Bedford, and the purchase of dredging plant to the value of $1,104.49.

WORK REQUIRED TO COMPLETE THE EXISTING PROJECT.

The work required to complete the existing project is the excavation of the remaining half of the channel 200 feet wide and 18 feet deep, extending from the "11-foot bank" to the vicinity of the wharves at New Bedford, and the removal of a few shoal spots between the "11-foot bank" and Butler's Flats, the southern end of the projected channel.

OPERATIONS CONTEMPLATED FOR THE FISCAL YEAR ENDING JUNE 30, 1891.

The work of dredging in the new channel will be continued if an appropriation is made therefor.

New Bedford Harbor is in the New Bedford collection district, which is a port of entry. The amount of revenue collected in the last fiscal year was $109,675.30.

The nearest light-houses are Clark's Point Light and the lights in New Bedford Harbor. The nearest fortification is the fort at Clark's Point, Mass.

Money statement.

July 1, 1889, amount available		$9,009.00
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$8,951.47	
July 1, 1890, outstanding liabilities	23.55	
		8,975.02
July 1, 1890, balance available		33.98
Amount appropriated by act of September 19, 1890		10,000.00
Amount available for fiscal year ending June 30, 1891		10,033.98
Amount (estimated) required for completion of existing project		15,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892		15,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

COMMERCIAL STATISTICS.

[Furnished by Mr. Weston Howland, collector of customs.]

Receipts.

Articles.	1888.	1889.	Articles.	1888.	1889.
	Tons.	*Tons.*		*Tons.*	*Tons.*
Lumber	19,496	16,125	Iron and steel	8,338	10,690
Coal	365,766	490,690	Sisal	111	127
Grain	2,498	18,458	Meal	.....	73
Cotton	3,613	6,106	Tar	256	294
Lime	1,812	.....	Hemp	43	58
Flour	55	327	Molding sand	888	800
Cement	1,287	1,827	Paving blocks	1,668	.....
Sugar	1,180	2,142	Wool	.....	249
Manila	149	212	Copper	.....	1,968

Number of arrivals at this port.

	1888.	1889.		1888.	1889.
Steamers	708	796	Ships	1	2
Barks	13	11	Brigs	2	1
Schooners	809	767	Sloops	29	.....
Barges	210	.....			

C 6.

IMPROVEMENT OF TAUNTON RIVER, MASSACHUSETTS.

This river rises in Norfolk County, Mass., and empties into Mount Hope Bay, a name given to the northeastern part of Narragansett Bay. It is about 44 miles in length, measured along its course.

The object of the improvement is to deepen and widen the channel leading to the city of Taunton, at the head of navigation, which requires large quantities of coal, iron, clay, moldings, sand, and other heavy articles for its extensive manufactures dependent largely on water transportation, so that vessels of 11 feet draught can reach the city at high water. The rise and fall of the tide before improvement was 5¼ feet at Dighton and 3.4 feet at Taunton.

ORIGINAL CONDITION.

In its original condition the channel was narrow and obstructed by bowlders, and from Berkley Bridge to Taunton the depth was not, in places, more than 5 feet at mean high water. A vessel of 30 tons burden was as large as could go up to Taunton.

PLANS OF IMPROVEMENT.

The approved project of 1871, and its subsequent modifications, provides for a channel 60 feet wide and 11 feet deep from Weir Bridge to the ship-yard; a channel 80 feet wide (100 feet at the bends) and 11 feet deep from the ship-yard down to and through the Needles and Brigg's Shoal; thence to Berkley Bridge a channel of the same width and 12 feet deep. From Berkley Bridge to the deep water at Dighton the channel was to be 100 feet wide and 12 feet deep. The depths are estimated from high waters. The ledge which crossed the bottom of the river at Peter's Point and the numerous bowlders which lay on the bottom and sides of the channel from Taunton to Dighton were to be removed.

A plat of the river showing the improved channel was published in the Annual Report of the Chief of Engineers for 1884, page 606.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1889.

The amount expended on the improvement of the river up to the close of the fiscal year ending June 30, 1889, including liabilities outstanding at that date, was $156,967.72.

With the exception that but 40 feet of the 60 feet of width could be dredged between the bridge at Weir and the ship-yard on account of interfering with private property, and that on account of the hardness and depth of material at the sides the 80-foot channel was not in all

cases dredged to its full width, the channel down to Berkley Bridge had been completed. The channel as proposed between Berkley Bridge and Dighton had been completed, with the exception of removing a small amount of ledge rock uncovered in dredging, and had been cleared of bowlders from Taunton down to Berkley Bridge. The work of removal of the ledge at Peter's Point had been completed. The material blasted in the channel had been dredged and deposited in the form of a half-tide dam running from Reuben's Island to the west shore of the river, with the view of accelerating the current in the dredged channel off and above Dighton and preventing deposits in that part of the channel. Vessels of 11 feet draught can now reach Taunton at the head of navigation.

OPERATIONS DURING THE LAST FISCAL YEAR.

No work was done during the last fiscal year.

WORK REQUIRED TO COMPLETE THE EXISTING PROJECT.

There remains to complete the existing project the widening and deepening of the channel at a few points above the bridge and the removal of the small amount of ledge rock above referred to. This ledge projects about 30 feet into the eastern side of the channel, diminishing its depth by a few inches, while there is ample width and depth beyond the channel line on the western side.

In compliance with the provisions of the river and harbor act of August 5, 1886, a survey of portions of Taunton River was made in October, 1887, and the map and report thereon were submitted to the Chief of Engineers November 21, 1887, and were printed in House Ex. Doc. No. 86, Fiftieth Congress, first session. The estimated cost of this additional improvement is $14,051.

OPERATIONS CONTEMPLATED FOR THE FISCAL YEAR ENDING JUNE 30, 1891.

It is proposed to complete the existing project for the improvement of the river if funds are appropriated therefor.

Taunton River is in the Fall River collection district. Fall River is the nearest port of entry. The amount of revenue collected at Fall River in the last fiscal year was $99,153.37. The nearest light-house is the Borden Flat light-house. The nearest fortification is Fort Adams, Newport Harbor, Rhode Island.

Money statement.

July 1, 1889, amount available		$32.28
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$4.50	
July 1, 1890, outstanding liabilities	15.00	
		19.50
July 1, 1890, balance available		12.78
Amount appropriated by act of September 19, 1890		7,000.00
Amount available for fiscal year ending June 30, 1891		7,012.78
Amount (estimated) required for completion of existing project		7,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892		7,000.00

Submitted in compliance with reqirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

[Furnished by Mr. H. A. Dean, Taunton, Mass.]

Receipts.

Articles.	1888.	1889.	Articles.	1888.	1889.
	Tons.	*Tons.*		*Tons.*	*Tons.*
Lumber	16,250	16,250	Metals of all kinds	33,000	.....
Grain	39,774	39,600	Cotton	6,750	6,250
Flour	4,500	4,000	Molding sand	24,000	30,000
Coal	265,000	285,000	Clay	30,000	35,000
All other merchandise	30,000	35,000			

Number of vessels employed on Taunton River.

Year.	Sailing.	Barges.	Tugs.	Average draught.	Average tonnage.
				Feet.	
1889	46	9	4	10	500
1890	48	10	4	10	550

C 7.

IMPROVEMENT OF WARREN RIVER, RHODE ISLAND.

Warren River is an arm of Narragansett Bay, north of the harbor of Bristol. The obstructions to navigation were a rocky reef below Little Island, and a submerged bowlder, known as Bushworth Rock, near mid-channel, opposite the lower wharf of the town of Warren. By act approved August 5, 1886, Congress appropriated $5,000 for the improvement of the river, and with this sum it was proposed that the bowlder and reef referred to be removed as far as possible.

PLANS OF IMPROVEMENT.

The work of improvement was one that could not be well carried on by contract, and the approved project was first to remove Bushworth Rock, and afterwards to remove the bowlders which lay submerged on the western side of the narrowest portion of the channel at Little Island, and also the projecting portions of the ledge beneath the bowlders, widening the channel as much as the funds available permitted; it also included the hiring in open market of a vessel with working crew, submarine diver, firing battery, and steam-hoisting apparatus, and purchase of the explosives also in open market.

A plat of the river, showing the proposed improvement near Little Island, was published in the Annual Report of the Chief of Engineers for 1885, page 630.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1889.

The amount expended to June 30, 1889, including liabilities outstanding at that date, was $4,849.72. The result was the removal of Bushworth Rock to the depth of the surrounding water, and the removal of the bowlders and points of ledge rock over an area of about 1.8 acres in the vicinity of Little Island, extending 550 feet along the narrowest

part of the channel. This work finished the improvement as far as projected.

OPERATIONS DURING THE LAST FISCAL YEAR.

No work was done during the last fiscal year.

Warren River is in the Bristol-Warren collection district, which is a port of entry. The amount of revenue collected in the last fiscal year is unknown. The nearest light-house is the light-house on Conimicut Point, Providence River. The nearest fortifications are fort on Dutch Island and Fort Adams, Rhode Island.

Money statement.

July 1, 1889, amount available		$119.78
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$93.99	
July 1, 1890, outstanding liabilities	16.86	
		110.85
July 1, 1890, balance available		8.93

COMMERCIAL STATISTICS.

[Furnished by Mr. John Waterman, Warren, R. I.]

Articles.	1888.	1889.	Articles.	1888.	1889.
	Tons.	*Tons.*		*Tons.*	*Tons.*
Coal	16,090	14,089	Oysters	.....	1,350
Lumber	2,146	1,625	Lime and cement	180	150
Grain	2,100	2,610	Cotton	1,044	490
Feed	250	290			

Arrivals and departures.

Year.	Schooners.	Steamers.	Barges.	Tow-boats.	Average Draught.
1888	81	4	.....	.....	13
1889	64	4	5	10	13

C 8.

IMPROVEMENT OF PAWTUCKET RIVER, RHODE ISLAND.

The navigable part of the Pawtucket (or Seekonk) River, an arm of Providence River, extends from Providence to Pawtucket, a city which in 1885 had a population of about 23,000, and extensive manufactures, depending largely on water transportation. The object of the improvement is to widen and deepen the channel leading to Pawtucket, so that vessels of 12 feet draught can reach that city at mean low water. The mean rise and fall of the tide is about 5 feet.

ORIGINAL CONDITION.

Before improvement the channel in the river had a ruling depth of *about 5 feet* at mean low water.

PLANS OF IMPROVEMENT.

The original project, as modified in 1883, provides for the excavation by dredging of a channel 100 feet wide and 12 feet deep at mean low water from the deep water above Red Bridge to the ledge opposite Grant & Co.'s Wharf at Pawtucket; thence the deepening by blasting of the channel through the ledge to Pawtucket Bridge to the same depth, and 40 feet wide.

A plat of the river showing the lines of the proposed channel was published in the Annual Report of the Chief of Engineers for 1884, page 608.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1889.

The total amount expended up to the close of the fiscal year ending June 30, 1889, including liabilities outstanding at that date, was $134,505.83. The channel had been excavated under the original project to a width of 75 feet and a ruling depth of 7 feet at mean low water, and under the project as modified in 1883 a new channel 12 feet deep and 100 feet wide, with wide enlargements at the bends, has been carried from its mouth at the deep water just above Red Bridge, a distance of about 12,740 feet. There is now a channel 100 feet wide and 12 feet deep at mean low water from the deep water above Red Bridge to Bass Rock, or to within about 1¼ miles of the head of navigation.

This completed portion of the channel is already a great benefit to the commerce of the river. A ruling depth of about 6 feet can be carried from the upper end of our present work to Pawtucket.

OPERATIONS DURING THE LAST FISCAL YEAR.

At the beginning of the last fiscal year no work was in progress. The dredge *Newport*, hired of Brainard Brothers, of New York, commenced dredging August 29, 1889, and continued until November 9, 1889, when it was transferred to other work. The dredge *Yankee Notion*, hired of D. M. & C. W. Anthony, of Fall River, Mass., was engaged on the work from September 5 to October 1 in dredging one cut through the shoalest places that the scows of the larger dredge might work to better advantage. The dredge *C. H. Latham*, hired of the Hartford Dredging Company, was also engaged on this work from December 26 until January 23, when it was withdrawn on account of the liability of the river to freeze over. During the fiscal year 54,923 cubic yards of sand and 128 cubic yards of bowlders and ledge rock, besides numerous stumps, logs, and fallen trees, were excavated from the projected channel.

AMOUNT EXPENDED DURING THE LAST FISCAL YEAR AND RESULTS TO JUNE 30, 1890.

The amount expended during the last fiscal year, including liabilities outstanding to June 30, 1890, was $32,500.13 and the result was the dredging of the channel to a width of 60 feet from Bass Rock to a point about 200 feet above Dunnell's Wharf, which, in the opinion of those interested in the navigation of the river, it has been especially desirable to reach; and the purchase of dredging plant to the value of $10,805.61.

WORK REQUIRED TO COMPLETE THE EXISTING PROJECT.

The work yet to be done is to excavate the channel to its full width of 100 feet from Bass Rock to a point opposite Grant & Co.'s Wharf, and thence to Pawtucket Bridge, to deepen the channel through the ledge to the same depth with a width of 40 feet.

OPERATIONS CONTEMPLATED FOR THE FISCAL YEAR ENDING JUNE 30, 1891.

It is proposed to extend the channel toward Pawtucket by dredging and to commence work on the ledge. For this reason an appropriation of $100,000 is asked, instead of $50,000 as heretofore.

Pawtucket is in the collection district of Providence, and that port is the nearest port of entry. The amount of revenue collected at Providence in the last fiscal year was $269,858.00. The nearest light-house is Sassafras Point Light. The nearest fortifications are Fort Adams, Newport, R. I., and the fort on Dutch Island, Rhode Island.

Money statement.

July 1, 1889, amount available		$32,500.13
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$31,844.08	
July 1, 1890, outstanding liabilities	656.05	
		32,500.13
Amount appropriated by act of September 19, 1890		30,000.00
Amount (estimated) required for completion of existing project		337,478.00
Amount that can be profitably expended in fiscal year ending June 30, 1892		100,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

[Furnished by Business Men's Association, Pawtucket, R. I.]

Receipts.

Articles.	1890.	Articles.	1890.
	Tons.		*Tons.*
Coal	121,594	N. R. stone	116
Lumber	2,777	Spool wood	460
Pickets	31	Iron	505
Laths	101	Fertilizer material	100
Shingles	39	Acid phosphate	175
Bricks	3,838	Potash	150
Lime	591	Gravel	262
Cement	495	Cotton	51
Fire-clay	5		

C 9.

IMPROVEMENT OF PROVIDENCE RIVER AND NARRAGANSETT BAY, RHODE ISLAND.

Providence River is an estuary of Narragansett Bay. The object of its improvement is to furnish a wide and deep channel for European and coastwise commerce from the ocean to Providence, a city which had in 1885 about 125,000 inhabitants, largely engaged in manufactures, and

a port of entry for an extensive region of country, with which it is connected by railroads. The mean rise and fall of the tide is 4.7 feet.

ORIGINAL CONDITION.

Before the improvement of the river was commenced, in 1853, many shoals obstructed navigation, and at one point in the channel, a place called "The Crook," the available low-water depth was but 4½ feet.

PLANS OF IMPROVEMENT.

There was expended between 1852 and the 30th of June, 1882, $290,459.34 in deepening the channel; first to 9 feet, then to 12 feet, then to 14 feet, and again to 23 feet, as the increasing sizes of vessels and the growing commerce of Providence demanded. Bulkhead Rock was also removed during this period to a depth of 20 feet below mean low water.

The approved project of 1878, modified in 1882, under which we are now working, provides for a channel 25 feet deep and 300 feet wide, suitable for large ocean vessels, extending from Fox Point, in the city of Providence, to the deep water of Narragansett Bay, and for an anchorage basin between Fox and Field's points of the following dimensions in cross-sections, viz:

300 feet wide, 25 feet deep.
600 feet wide, 20 feet deep.
725 feet wide, 18 feet deep.
940 feet wide, 12 feet deep.
1,060 feet wide, 6 feet deep.

The 25-foot channel has been laid out in straight reaches (with enlargements at the angles) with a view to lighting them by range or leading lights, such as are used in similar cases in Chesapeake Bay, Delaware River, and other localities, if it should be found necessary.

A plat of Providence River, showing the improved channel, was published in the Annual Report of the Chief of Engineers for 1884, page 622.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1889.

The amount expended on the present project up to the close of the fiscal year ending June 30, 1889, including liabilities outstanding at that date was $246,883.36. At that date the 25-foot channel, 300 feet wide, had been completed. Bulkhead Rock had been removed. The excavation of the 20-foot anchorage area has been completed in Fox Point Reach, and of the same areas in the Sassafras Point and the Field's Point reaches about one-fourth and one-half, respectively, has been done.

OPERATIONS DURING THE LAST FISCAL YEAR.

At the beginning of the last fiscal year no work was in progress. August 13 the dredge *Newport*, hired of Brainard Bros., of New York, began work on the 18-foot area, Fox Point Reach, east side. Work was carried on with this dredge until August 28, 1889, when it was transferred to Pawtucket River. A dredge, hired of Henry Du Bois's Sons, of New York, continued the work until November 9, 1889, when it was transferred to New Bedford. The United States dredge *Texas* was engaged on this work from December 3 to 20, inclusive, and the dredge *C. H. Latham*, hired of the Hartford Dredging Company, was also at work here from January 24 to February 8, 1890, when it was transferred

WORK REQUIRED TO COMPLETE THE EXISTING PROJECT.

The work yet to be done is to excavate the channel to its full width of 100 feet from Bass Rock to a point opposite Grant & Co.'s Wharf, and thence to Pawtucket Bridge, to deepen the channel through the ledge to the same depth with a width of 40 feet.

OPERATIONS CONTEMPLATED FOR THE FISCAL YEAR ENDING JUNE 30, 1891.

It is proposed to extend the channel toward Pawtucket by dredging and to commence work on the ledge. For this reason an appropriation of $100,000 is asked, instead of $50,000 as heretofore.

Pawtucket is in the collection district of Providence, and that port is the nearest port of entry. The amount of revenue collected at Providence in the last fiscal year was $269,858.00. The nearest light-house is Sassafras Point Light. The nearest fortifications are Fort Adams, Newport, R. I., and the fort on Dutch Island, Rhode Island.

Money statement.

July 1, 1889, amount available		$32,500.13
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$31,844.08	
July 1, 1890, outstanding liabilities	656.05	
		32,500.13
Amount appropriated by act of September 19, 1890		30,000.00
Amount (estimated) required for completion of existing project		337,478.00
Amount that can be profitably expended in fiscal year ending June 30, 1892		100,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

[Furnished by Business Men's Association, Pawtucket, R. I.]

Receipts.

Articles.	1890.	Articles.	1890.
	Tons.		*Tons.*
Coal	121,594	N. R. stone	116
Lumber	2,777	Spool wood	450
Pickets	31	Iron	505
Laths	101	Fertilizer material	100
Shingles	39	Acid phosphate	175
Bricks	3,838	Potash	150
Lime	591	Gravel	262
Cement	495	Cotton	51
Fire-clay	5		

C 9.

IMPROVEMENT OF PROVIDENCE RIVER AND NARRAGANSETT BAY, RHODE ISLAND.

Providence River is an estuary of Narragansett Bay. The object of its improvement is to furnish a wide and deep channel for European and coastwise commerce from the ocean to Providence, a city which had in 1885 about 125,000 inhabitants, largely engaged in manufactures, and

a port of entry for an extensive region of country, with which it is connected by railroads. The mean rise and fall of the tide is 4.7 feet.

ORIGINAL CONDITION.

Before the improvement of the river was commenced, in 1853, many shoals obstructed navigation, and at one point in the channel, a place called "The Crook," the available low-water depth was but 4½ feet.

PLANS OF IMPROVEMENT.

There was expended between 1852 and the 30th of June, 1882, $290,459.34 in deepening the channel; first to 9 feet, then to 12 feet, then to 14 feet, and again to 23 feet, as the increasing sizes of vessels and the growing commerce of Providence demanded. Bulkhead Rock was also removed during this period to a depth of 20 feet below mean low water.

The approved project of 1878, modified in 1882, under which we are now working, provides for a channel 25 feet deep and 300 feet wide, suitable for large ocean vessels, extending from Fox Point, in the city of Providence, to the deep water of Narragansett Bay, and for an anchorage basin between Fox and Field's points of the following dimensions in cross-sections, viz:

300 feet wide, 25 feet deep.
600 feet wide, 20 feet deep.
725 feet wide, 18 feet deep.
940 feet wide, 12 feet deep.
1,060 feet wide, 6 feet deep.

The 25-foot channel has been laid out in straight reaches (with enlargements at the angles) with a view to lighting them by range or leading lights, such as are used in similar cases in Chesapeake Bay, Delaware River, and other localities, if it should be found necessary.

A plat of Providence River, showing the improved channel, was published in the Annual Report of the Chief of Engineers for 1884, page 622.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1889.

The amount expended on the present project up to the close of the fiscal year ending June 30, 1889, including liabilities outstanding at that date was $246,883.36. At that date the 25-foot channel, 300 feet wide, had been completed. Bulkhead Rock had been removed. The excavation of the 20-foot anchorage area has been completed in Fox Point Reach, and of the same areas in the Sassafras Point and the Field's Point reaches about one-fourth and one-half, respectively, has been done.

OPERATIONS DURING THE LAST FISCAL YEAR.

At the beginning of the last fiscal year no work was in progress. August 13 the dredge *Newport*, hired of Brainard Bros., of New York, began work on the 18-foot area, Fox Point Reach, east side. Work was carried on with this dredge until August 28, 1889, when it was transferred to Pawtucket River. A dredge, hired of Henry Du Bois's Sons, of New York, continued the work until November 9, 1889, when it was transferred to New Bedford. The United States dredge *Texas* was engaged on this work from December 3 to 20, inclusive, and the dredge *C. H. Latham*, hired of the Hartford Dredging Company, was also at work here from January 24 to February 8, 1890, when it was transferred

to other work. Ninety-six thousand and thirty-four cubic yards of mud were excavated, finishing the 20-foot area on the east side of the main channel of Sassafras Point Reach, and the 18-foot area on the east side of Fox Point, and about three fourths of the 18-foot area on the same side of Sassafras Point Reach.

AMOUNT EXPENDED DURING THE LAST FISCAL YEAR AND RESULTS TO JUNE 30, 1890.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1890, was $36,717.27, and the result was the completion of the 20-foot anchorage area on the east side of the Sassafras Point Reach, and the 18-foot area on the east side of the Fox Point Reach, and about three-fourths of the 18-foot area on the same side of the Sassafras Point Reach, and the purchase of plant to the value of $18,326.53.

WORK REQUIRED TO COMPLETE THE EXISTING PROJECT.

There is required for the completion of the existing project the remainder of the excavation of the anchorage basin between Fox and Field's points.

OPERATIONS CONTEMPLATED FOR THE FISCAL YEAR ENDING JUNE 30, 1891.

It is proposed to continue the excavation of the anchorage area.

Providence River is in the collection district of Providence, which is a port of entry. The amount of revenue collected at Providence in the last fiscal year was $269,858.00. The nearest light-houses are the six light-houses in Providence River. The nearest fortifications are fort on Dutch Island and Fort Adams, R. I.

Money statement.

July 1, 1889, amount available		$36,717.27
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$35,829.71	
July 1, 1890, outstanding liabilities	887.56	
		36,717.27
Amount appropriated by act of September 19, 1890		50.000.00
Amount (estimated) required for completion of existing project		115,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892		100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

COMMERCIAL STATISTICS.

[Furnished by Providence Board of Trade.]

Foreign imports.

Articles.	1889.	Articles.	1889.
	Tons.		*Tons.*
Lumber	3,632	Ice	509
Shingles	657	Wool	3,815
Laths	1,407	Starch	149
Wood	1,166	Lime	121
Logwood	3,821	Potatoes	108
Pickets	54	Liquors	14
Piling	812	Tobacco	1
Brimstone	590		

By water and rail.

Articles.	1889.	Articles.	1889.
	Tons.		*Tons.*
Cotton	55,105	Flour	28,668
Wool	12,388	Grain	44,478
Coal	1,054,314	Dry goods	5,266
Iron and steel	65,876	Print cloths	2,616
Oil	24,003	Chemicals	3,343
Waste	5,811	Liquors	9,553
Beef	12,486		

C 10.

REMOVAL OF GREEN JACKET SHOAL, PROVIDENCE RIVER, RHODE ISLAND.

Green Jacket Shoal is in that part of Providence River which constitutes the harbor of Providence.

It lies off the wharves on the south front of the city, and occupies a part of the harbor that is required for anchorage purposes.

ORIGINAL CONDITION.

That part of the harbor in which the shoal is located is about 2,000 feet long by from 600 to 1,200 feet wide; and of this area the shoal, or rather that part of it which was included between the 15-foot curves, takes up about 18 acres. There were channels on either side of the shoal, between it and the harbor lines, having, the one on the north side a width of 300 feet and a depth of 20 feet, and the one on the south side a width varying from 50 to 100 feet and a depth of about 15 feet at mean low water. The water on the summit of the shoal was 1 foot deep.

PLANS OF IMPROVEMENT.

The general project is the removal of the entire shoal to a depth of 25 feet at mean low water, limiting the work by lines drawn 200 feet from the harbor lines.

A plat of Green Jacket Shoal was published in the Annual Report of the Chief of Engineers for 1885, Vol. I, page 599.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1889.

The amount expended, including outstanding liabilities, to June 30, 1889, was $28,064.37. The result was the excavation to a depth of 25 feet at mean low water of an area of about 9¼ acres, extending along the western side of the shoal, making an important addition to the anchorage facilities of the harbor. On a portion of this area the depth of water before the completion of the contract of November 18, 1886, was from 3 to 4 feet.

OPERATIONS DURING THE LAST FISCAL YEAR.

At the beginning of the last fiscal year no work was in progress. August 8, 1889, a dredge, hired of Henry Du Bois's Sons, commenced work on the shoal. The cuts were made parallel to the general direction of the harbor line on the north side of the shoal, and an area of

about 4½ acres was excavated to the required depth of 25 feet. On November 9, 1889, this dredge was transferred to other work. From January 6 to February 8, 1890, the United States dredge *Rhode Island* was at work on this shoal. The amount of material excavated was 147,520 cubic yards of mud and oyster shells.

AMOUNT EXPENDED DURING THE LAST FISCAL YEAR AND RESULTS TO JUNE 30, 1890.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1890, was $26,185.63, and the result was the enlargement of the anchorage area by about 4½ acres, and the purchase of plant to the value of $7,177.04.

WORK REQUIRED TO COMPLETE THE EXISTING PROJECT.

The work required to complete the existing project is the excavation of the remainder of the shoal to a depth of 25 feet.

OPERATIONS CONTEMPLATED FOR THE FISCAL YEAR ENDING JUNE 30, 1891.

It is proposed to continue the removal of the shoal according to the general project.

Green Jacket Shoal is in the collection district of Providence, which is a port of entry. The amount of revenue collected at Providence during the last fiscal year was $269,858.00. The nearest light-houses are the six light-houses in Providence River. The nearest fortifications are Fort Adams, R. I., and the fort on Dutch Island, Rhode Island.

For the commercial statistics, see report of the improvement of Providence River and Narragansett Bay, Rhode Island.

Money statement.

July 1, 1889, amount available		$26,185.63
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$26,162.13	
July 1, 1890, outstanding liabilities	23.50	
		26,185.63
Amount appropriated by act of September 19, 1890		25,000.00
Amount (estimated) required for completion of existing project		33,096.00
Amount that can be profitably expended in fiscal year ending June 30, 1892		33,096.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

C 11.

IMPROVEMENT OF NEWPORT HARBOR, RHODE ISLAND.

This harbor is at the main entrance to Narragansett Bay. These waters during the summer and winter constitute a harbor of refuge for our European and coastwise commerce quite equal in every respect to that of New York Harbor, and are even more accessible. The objects of the improvement are to widen and deepen the southern (the main)

entrance to the harbor, and to enlarge its capacity for vessels seeking refuge in storms, by increasing the area and depth of the anchorage within it. The mean rise and fall of the tide is about 3¾ feet.

ORIGINAL CONDITION.

Before improvement the capacity of the inner harbor was limited by shoals, and it was not adequate to the number and size of vessels seeking it for refuge. The southern (the main) entrance was obstructed by a bar which stretched out from Goat Island, and the general business wharves of the city could not be reached at low tide by vessels drawing more than 8 feet.

PLANS OF IMPROVEMENT.

The original project and its modifications under which we are now working are substantially as follows:

Deepening the southern entrance to 15 feet at mean low water and widening it by dredging Goat Island Spit northward to a line drawn from the dolphin which marks the spit to clear the permanent dock at Fort Adams by 100 feet; the excavation of a channel 750 feet wide and 15 feet deep at mean low water around and to the eastward of this dolphin; excavating to 13 feet at mean low water the area included between the 13-foot curve on the west, a line drawn from the southwest corner of Perry Mill Wharf to Lime Rock on the south, the harbor line on the east, and a line drawn parallel to and 50 feet from the city wharf on the north; excavating to 10 feet at mean low water the area northwest of a line drawn from Lime Rock through the spindle, which is in the southeast part of the harbor; the excavation of a channel 10 feet deep at mean low water along and outside the harbor line south to a point opposite the gas company's wharf, and the construction of jetties on the western shore of Goat Island to arrest the drift of littoral sand and gravel into the southern entrance.

A plat of Newport Harbor, showing the plans of the work, was published in the Annual Report of the Chief of Engineers for 1885, Vol. I, page 604.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1889.

The amount expended up to the close of the fiscal year ending June 30, 1889, including outstanding liabilities at that date, was $109,489.21, with the following results:

Of the area to be dredged to 13 feet within the harbor, about nine-tenths had been completed. The channel along and outside the harbor line south to a point opposite the gas company's wharf, and the 15-foot channel 750 feet wide around and to the eastward of the dolphin on Goat Island Spit, had been completed, with the exception of a strip along the western edge and to the north of the dolphin. The berth for vessels at the quartermaster's wharf at Fort Adams had been deepened to 10 feet at mean low water, and the littoral sand from the outside of Goat Island had been stopped for the present from washing into the channel at the southern entrance of the harbor by the construction of a jetty on the west side of the island. The southern entrance is completed for vessels of 15 feet draught, and of the total area to be dredged within the harbor (about 90 acres) about two-thirds have been completed.

OPERATIONS DURING THE LAST FISCAL YEAR.

At the beginning of the last fiscal year no work was in progress. On August 2, 1889, a dredge hired of Henry Du Bois's Sons, of New York, commenced work in the 13-foot anchorage area, but was soon afterward removed to Providence. On August 27 a dredge hired of D. M. & C. W. Anthony, of Fall River, Mass., arrived in Newport, but on September 3 was transferred to Pawtucket to temporarily assist in the work there. On the 4th of October this dredge returned to Newport, and remained at work in the harbor until November 27. On November 13 and 14 two dredges, while en route to New Bedford from Providence, were detained in Newport harbor by bad weather, and the time was utilized in dredging. On the 12th of November a dredge hired from the Hartford Dredging Company commenced work in the harbor and continued until December 21, when it was taken off for other work until February 10, when it returned and worked until March 7. The United States dredge *Rhode Island* was also engaged on this work from November 2 to 16 and February 10 until March 8. Thirty-nine thousand six hundred and one cubic yards of material were excavated from the 13-foot anchorage area and from the western edge of the 15-foot channel north of the dolphin, and a small amount from near the north end of Goat Island.

AMOUNT EXPENDED DURING THE LAST FISCAL YEAR AND RESULTS TO JUNE 30, 1890.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1890, was $10,712.82, and the result was the completion of the 13-foot anchorage area and the dredging of one cut along the western edge of the 15-foot channel north of the dolphin, and the purchase of plant to the value of $355.40.

WORK REQUIRED TO COMPLETE THE EXISTING PROJECT.

The work required to complete the existing project is the dredging of the remainder of the narrow strip along the western edge of the 15-foot channel north of the dolphin and the excavation of the 10-foot anchorage area within the harbor, also the building of additional jetties outside of Goat Island whenever they may be required to arrest the drift of littoral sand and gravel into the harbor entrance.

OPERATIONS CONTEMPLATED DURING THE FISCAL YEAR ENDING JUNE 30, 1891.

It is proposed to complete the 15-foot channel as projected and extend the anchorage area as far as possible to the east and south.

Newport is in the collection district of Newport, and is a port of entry. The amount of revenue collected at Newport in the last fiscal year was $3,380.14. The nearest lighthouses are Lime Rock and Newport (Goat Island) lights. The nearest fortification is Fort Adams, Newport, R. I.

Money statement.

July 1, 1889, amount available		$10,712.82
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$10,701.14	
July 1, 1890, outstanding liabilities	11.68	
		10,712.82
Amount appropriated by act of September 19, 1890		12,500.00

Amount (estimated) required for completion of existing project	$27,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	27,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

[Furnished by Mr. J. H. Cozzens, collector of customs.]

Receipts.

Articles.	1889.	1890.	Articles.	1889.	1890.
	Tons.	*Tons.*		*Tons.*	*Tons.*
Lumber	19,749	18,855	Drain pipe		5,000
Shingles	704	950	Sand and gravel		10,000
Laths	1,294	1,062	Flagstone		1,000
Coal	50,000	50,000	Granite		20,000
Lime	2,550	2,250	Iron		2,000
Cement	1,950	1,650	Ashes		41
Brick	18,000	18,800	Fish		2,000
Hay	1,500	5,000	Potatoes		1,800
Grain	1,200	1,800	Plaster		375
Cord-wood		1,250	Hair		200
Marble		1,500			

Shipping.

Years.	Arrivals of vessels from foreign ports.		Vessels owned in Newport.	
	Number.	Value of cargoes.	Number.	Gross tonnage.
1889	29	$16,271.92	143	7,694.54
1890	19	17,398.59	148	7,972.93

C 12.

HARBOR OF REFUGE AT BLOCK ISLAND, RHODE ISLAND.

This island is a part of the State of Rhode Island; it is 14 miles east of Montauk Point, the eastern end of Long Island, and its nearest point is about 10 miles from the mainland. Besides the wants of the mackerel-fishing fleet and the general coast navigation the island is an important point on our shores for ocean navigation. It has a signal station connected by submarine telegraph with the mainland. Vessels are passing the island at all times and on all sides of it, and its position renders it of national importance The object of the improvement is to furnish a harbor of refuge for vessels engaged in foreign and coastwise commerce. The mean rise and fall of the tide is about 3 feet.

ORIGINAL CONDITION.

Before the construction of the present harbor of refuge Block Island had no harbor which afforded protection for decked vessels. The only ones used were open boats, which, on the approach of storms, were hauled up on the beach by oxen. The largest of these boats were of about 10 tons burden.

PLANS OF THE WORK.

The original project and its subsequent modifications provided for a harbor of refuge on the eastern side of the island, consisting of an inner harbor or basin for small vessels and an exterior harbor for large ones. The basin was to be about 250 by 300 feet in area, and inclosed, with the exception of an opening of 80 feet in width. The exterior harbor was to be formed by a riprap breakwater, which has been built. About 300 feet from the sea end of this breakwater, which is 1,000 feet long, a gap 200 feet long was left for the convenience of vessels. The present project contemplates the filling of this gap and restoring the breakwater to its original dimensions, the enlargement of the inner harbor, and the removal of a shoal along the western side of the breakwater. A plat of Block Island, showing the position of the harbor of refuge and a plan of the works, may be found in the Report of the Chief of Engineers for 1885, vol. 1, pages 612, 613.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1889.

The total expenditures up to June 30, 1889, including liabilities outstanding at that date, was $340,931.39.

The inner harbor and the main breakwater, built in prolongation of the eastern side of the inner harbor, and extending 1,900 feet from the shore, were constructed in the years 1870 to 1879, inclusive. The utility of the work at once became apparent. In stormy weather the inner harbor especially was filled with fishermen and coasters, and it soon became necessary to increase its depth from 7 feet, to which it had been dredged in the first instance, to 9 feet at mean low water. A strong jetty had been built out from the cliff to the eastward of the inner harbor and a masonry wall constructed on the inside of the crib-work forming the eastern side of the inner harbor. The filling of the gap in the main breakwater had been carried to an extent sufficient to keep out the sea which was formerly driven through it into the outer harbor in easterly storms. The timber jetty filled with stone forming the shore end of the western wall of the enlarged inner harbor and about 160 feet of its north wall east of the opening into the harbor had been finished, and about 90 feet of the wall west of the opening built to the level of mean high water.

OPERATIONS DURING THE LAST FISCAL YEAR.

At the beginning of the last fiscal year no work was in progress. Work was resumed on the north wall of the enlarged inner harbor August 3, 1889, and 1,941 tons of riprap granite were placed in it and 420 tons on the breakwater during the last fiscal year. Of the stone delivered 1,265 tons were taken from Mason's Island Quarry, which is operated by the Government. November 18, 1889, the United States dredge *Rhode Island* commenced dredging in the enlarged inner harbor on the bar that had been formed on the western side of the breakwater.

The dredging extended from the end of the steam-boat wharf to within about 100 feet of the north wall. Three thousand and twenty-five yards of sand were dredged, making a depth of 9 feet at mean low water. The dredging was discontinued on December 28, 1889, and the dredge transferred to other work. Mr. F. I. Angell was the local superintendent of the work.

AMOUNT EXPENDED DURING THE LAST FISCAL YEAR AND RESULTS TO JUNE 30, 1890.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1890, was $13,194.20, and the result was the extension of the north wall of the enlarged inner harbor 50 feet to the westward, and the use of 420 tons of stone in the proposed repairs to the breakwater and deepening the water to 9 feet on that part of the bar within the enlarged inner harbor that lies between the steam-boat wharf and a line 100 feet from the north wall; also the purchase of plant to the value of $4,201.48.

THE WHARF AT BLOCK ISLAND.

In the annual reports of the officer in charge for some years past, attention has been called to the dilapidated and dangerous condition of the wharf. It is on the land side of the inner harbor and was built by the United States for purposes of construction of that work. Since completion of the inner harbor the only use of the wharf by the Government has been for the purpose of landing mails and supplies for the light houses, etc. This use it is thought does not warrant an estimate for its repair or reconstruction, which would cost perhaps $2,500.

In his annual report for the year 1886, Colonel Elliot, for reasons which were fully set forth, recommended that this wharf be turned over to the town of New Shoreham, the corporate name of Block Island, and that the following provision be attached to the item for Block Island in the next river and harbor bill:

Provided, That the wharf on the land side of the inner harbor may be turned over to the town of New Shoreham for the public use of said town; but no tolls or charges shall ever be exacted for the use of said wharf by public vessels of the United States, or freight carried in such vessels.

And I would respectfully renew the recommendation.

During the past year the wharf has been temporarily repaired by the citizens of Block Island at their own expense. The location of the wharf may be seen in the plat published at page 613 of the Annual Report of the Chief of Engineers for 1885.

WORK REQUIRED TO COMPLETE THE EXISTING PROJECT.

The work required to complete the existing project is the completion of the filling of the gap in the main breakwater, the restoration of the breakwater to its original dimensions, and the enlargement of the inner harbor.

OPERATIONS CONTEMPLATED FOR THE FISCAL YEAR ENDING JUNE 30, 1891.

If an appropriation is made it is proposed to apply it to the continuation of the work according to the existing project.

Block Island is in the Newport collection district, and Newport is the nearest port of entry. The revenue collected at Newport in the last fiscal year was $3,380.14. There is no duty collected at the island. The value of the harbor is mainly as a harbor of refuge. There are several lights at the island. The nearest fortification is Fort Adams, R. I.

Money statement.

July 1, 1889, amount available		$13,854.12
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$11,682.64	
July 1, 1890, outstanding liabilities	1,511.56	
		13,194.20
July 1, 1890, balance available		659.92
Amount appropriated by act of September 19, 1890		15,000.00
Amount available for fiscal year ending June 30, 1891		15,659.92
Amount (estimated) required for completion of existing project		24,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892		24,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

[Furnished by Hon. Nicholas Ball, Block Island.]

Imports and exports.

Article.	1888.	1889.
	Tons.	*Tons.*
Coal received (about)	5,500	6,200
Iron received (about)	275	300
Grain received (about)	2,325	2,400
Lumber received (about)	5,592	5,722
General merchandise, not included in the above	15,500	16,200

Arrivals and departures.

	1888.	1889.
Steamers, from 50 to 1,000 tons, drawing from 3 to 10 feet of water	2,200	2,400
Sailing-vessels, from 10 to 200 tons, from 6 to 8 feet draught	116,000	117,000

C 13.

IMPROVEMENT OF PAWCATUCK RIVER, RHODE ISLAND AND CONNECTICUT.

The navigable part of Pawcatuck River extends from the manufacturing town of Westerly to Little Narragansett Bay, into which it empties. The approach to the river is through Stonington Outer Harbor and Little Narragansett Bay, and the object of the improvement is to deepen and widen the river channel leading from this bay to Westerly.

The mean rise and fall of the tide is 2.60 feet at the mouth of the river and 2.30 feet at Westerly.

ORIGINAL CONDITION.

Before improvement the channel was crooked and obstructed by numerous shoals, on some of which there was but 1½ feet at mean low water.

PLAN OF IMPROVEMENT.

By means of appropriations made in the years 1871–'75, the river was improved by the United States by the excavation of a channel 5½ feet deep at mean low water, and 75 feet wide below the wharves, and from 35 to 40 feet wide between the lower and upper wharves. The present project contemplates the widening of the channel to 100 feet below the wharves and by an additional width of two cuts of an ordinary dredging-machine, or about 40 feet between the lower and the upper wharves, also the deepening of the entire channel to 8 feet at mean low water.

A plat of Pawcatuck River, showing the channel-lines under the present project, was published in the Annual Report of the Chief of Engineers for 1885, Part I, pages 623–625.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1889.

The amount expended on the present project up to June 30, 1889, including liabilities outstanding, was $11,288.77, and the result was the completion of the channel to its full width and depth from the deep water opposite the village of Lottery to a point near the lower end of Major's Island, with the exception of small amounts of ledge rock which extend into the channel near Certain Draw Point and Pawcatuck Rock.

OPERATIONS DURING THE LAST FISCAL YEAR.

At the beginning of the last fiscal year no work was in progress. The work of removing the ledges at Certain Draw Point and Pawcatuck Rock commenced on July 29, 1889, was continued until October 30, 1889, when both ledges were removed to a depth of 8 feet at mean low water. Three hundred and thirty-nine and one-fourth tons of rock were removed from these ledges. The work of extending the channel toward Westerly was resumed March 9, 1890, by a dredge hired of the Hartford Dredging Company, and continued until April 5, 1890. Seven thousand five hundred and nine yards of sand and gravel were excavated and the channel extended about 500 feet towards Westerly. Mr. A. H. Dickens was local superintendent of the work.

AMOUNT EXPENDED DURING THE LAST FISCAL YEAR, AND RESULTS TO JUNE 30, 1890.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1890, was $9,573.85, and the result was that the channel was cleared of obstructions and extended to a point near the upper end on Major's Island, and the purchase of plant to the value of $1,761.54.

WORK REQUIRED TO COMPLETE THE EXISTING PROJECT.

The work required to complete the existing project is the dredging of the channel to a depth of 8 feet at mean low water and width of 100 feet from the upper end of the present work to Westerly, and a width of 40 feet between the upper and lower wharves of that town.

OPERATIONS CONTEMPLATED FOR THE FISCAL YEAR ENDING JUNE 30, 1891.

If an appropriation is made it is proposed to continue the work of widening and deepening the channel according to the existing project,

and also to afford such relief as the commerce of the river may require at the shoalest places in advance of the main work.

Pawcatuck River is in the collection districts of Providence and Stonington, the dividing line passing through the river. Providence and Stonington are the nearest ports of entry. The revenue collected in the last fiscal year was: Providence, $269,858.00; Stonington, $1,590. The nearest light-houses are the Stonington and Watch Hill lights. The nearest fortification is Fort Trumbull, New London, Conn.

Money statement.

July 1, 1889, amount available		$9,573.85
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$9,091.81	
July 1, 1890, outstanding liabilities	482.04	
		9,573.85
Amount appropriated by act of September 19, 1890		16,600.00
Amount (estimated) required for completion of existing project		37.00
Amount that can be profitably expended in fiscal year ending June 30, 1892		37.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

[Furnished by Messrs. Maxson & Co., Westerly, R. I.]

Receipts at Westerly by water.

Articles.	1888.	1889.
Coal ... tons	18,894	17,014
Sand ... do	892	1,275
Lumber ... feet	4,152,167	4,042,897
Bricks	1,195,700	351,000
Grain ... bushels	71,000	72,675
Pig-iron ... tons	925	1,094
Shipments.		
Stone ... tons	2,180	4,664
Lumber ... feet	.....	82,000

Number of passengers carried by steamers (about):

1888	50,000
1889	81,400

COMMERCIAL STATISTICS.

[Furnished by Messrs. Maxson & Co., Westerly, R. I.]

Receipts.

Articles.	1888.	1889.
	Tons.	*Tons.*
Coal	18,894	17,014
Sand	892	1,275
Lumber	5,399	5,256
Bricks	2,391	762
Grain	2,130	2,180
Iron	925	1,094
Shipments.		
Stone	2,180	4,664
Lumber	.....	107

Number of passengers carried by steamers in 1888, (about) 50,000.

C 14.

HARBOR OF REFUGE AT STONINGTON, CONNECTICUT.

Stonington Harbor lies on the north side of the eastern entrance from the ocean into Long Island Sound, and the main object of the improvement is to furnish a harbor of refuge for vessels entering and leaving this entrance to the sound. The mean rise and fall of the tide is about 2¾ feet.

ORIGINAL CONDITION.

Originally it was an open bay, unprotected from southerly storms, and obstructed by a shoal, having a low-water depth of but 6 feet at the shoalest part. This shoal nearly filled the inner harbor, and left but a narrow channel on either side of a depth insufficient to permit vessels of 12 feet draught to reach the upper wharves at low water.

PLANS OF THE WORK.

A short breakwater was constructed in the years 1828–1831, at a cost of $34,766.65, for the protection of the commerce of the town of Stonington The enlarged project of 1871 for the improvement of Stonington Harbor and its subsequent modification, under which work is now carried on, embraced dredging in the upper harbor and the construction of two breakwaters in the outer harbor. One of these (the western) was to be built out from Wamphassuck Point, the southwest limit of the harbor, and to extend about 2,000 feet, and the other (the eastern) was to extend from the vicinity of Bartlett's Reef to the Middle Ground. The western breakwater was completed in 1880, at a cost of $103,190. The amount expended in dredging the upper harbor was about $45,000. The position of the western end of the eastern breakwater has not been determined, but it will probably be found necessary, in order to afford all the protection desired, to extend the breakwater at least until it intersects a range from Stonington Light to the middle of Wicopessit Island. It may then be found desirable to carry it still further, possibly to the range from Stonington Light to the eastern end of Fisher's Island.

A plat of this harbor, showing the position of the breakwaters, was published in the Annual Report of the Chief of Engineers for 1884, page 632.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1889.

The amount expended on the eastern breakwater up to the close of the fiscal year ending June 30, 1889, including liabilities outstanding at that date, was $114,989.66, and its length at that date was 2,240 feet.

OPERATIONS DURING THE LAST FISCAL YEAR.

At the beginning of the last fiscal year the work of constructing the eastern breakwater was in progress under the contract of February 8, 1889, with Charles F. Stoll, of New London, Conn., which was finished August 17, 1889. One thousand nine hundred and twenty-five tons of stone were placed during the fiscal year. Mr. F. I. Angell, until August 1, 1889, and Mr. A. H. Dickens, until the completion of the contract, were local inspectors of the work.

AMOUNT EXPENDED DURING THE LAST FISCAL YEAR AND RESULTS TO JUNE 30, 1890.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1890, was $862.57, and the result was the extension of the eastern breakwater to a point about 2,290 feet from its eastern extremity, or about .89 of the shorter of the alternative lengths projected.

WORK REQUIRED TO COMPLETE THE EXISTING PROJECT.

The work required to complete the existing project is to finish the construction of the eastern breakwater. In case it be found that sufficient protection to the harbor of refuge has been afforded when the range from Stonington Light to the middle of Wicopessit Island is reached, the length of the breakwater yet to be built is about 280 feet. Should it be decided to extend it to the middle ground, it will require about 100 feet more.

By reason of the great danger to the large passenger steamers of the Stonington Line (New York and Boston), caused by the western end of the breakwater, especially in foggy and thick weather, and which will continue to exist until it is completed and a light-house and fog-signal are erected upon it, it is very desirable that the whole amount necessary to finish the breakwater should be included in one appropriation. The temporary light on the western end of the breakwater has been maintained.

The completion of this work will afford a thoroughly protected anchorage for vessels drawing 18 feet of water, and a harbor of refuge for the commerce which daily passes between Long Island Sound and the eastward.

OPERATIONS CONTEMPLATED FOR THE FISCAL YEAR ENDING JUNE 30, 1891.

If an appropriation is made, it is proposed to extend the eastern breakwater further to the westward.

Stonington Harbor is in the Stonington collection district and is a port of entry. The amount of revenue collected at Stonington in the last fiscal year was $1,590.00. The principal value of the harbor is as a harbor of refuge. The nearest lights are Stonington Light and Latimer's Reef Light. The nearest fortification is Fort Trumbull, New London Harbor, Connecticut.

Money statement.

July 1, 1889, amount available		$912.84
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$775.15	
July 1, outstanding liabilities	87.42	
		862.57
July 1, 1890, balance available		50.27
Amount appropriated by act of September 19, 1890		12,500.00
Amount available for fiscal year ending June 30, 1891		12,550.27
Amount (estimated) required for completion of existing project		12,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1892		12,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

[Furnished by Mr. H. G. Palmer, deputy collector.]

	1889.	1890.
Number of vessels entering from foreign ports	8	12
Number of vessels cleared for foreign ports	8	11
Value of merchandise imported	$6,037.00	$8,263.52
Amount of duties collected	$1,375.50	$1,590.00
Estimated value of cargoes coastwise	$36,000,000.00	$38,000,000.00
Estimated value of cargoes shipped coastwise	$34,500,000.00	$37,000,000.00
Value of product of fisheries	$100,000.00	$150,000.00
Number of vessels seeking harbor for refuge	2,400.00	3,600.00
Number of vessels registered in district	113.00	115.00
Tonnage, gross	6,328.38	9,118.52

C 15.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

WRECK OF SCHOONER SARAH L. SIMMONS.

The schooner *Sarah L. Simmons* was loaded with a cargo of paving stone and was bound from East Blue Hill, Maine, to New York. On September 11, 1889, she was wrecked, and sank in about 7 fathoms of water, about 700 yards northeast by east one-half east from Pollock Rip Light Ship, directly in the center of the main channel of communication for vessels plying between ports north and south of Cape Cod. Her dimensions were as follows: Length, 108.6; breadth, 30 feet; depth, 9.7 feet; gross tonnage, 242. She was owned in Philadelphia, Pa., and George W. Shepherd, jr., was her managing owner.

The notice required by section 4 of the river and harbor appropriation act of June 14, 1880, to all persons interested in the vessel, etc., was given by advertisement in newspapers, and proposals for removing the wreck were invited. No action having been taken by the owners, the proposals were opened November 21, 1889.

An abstract of proposals received and the terms of the contract will be found in the appended table.

Giant powder was used to remove the wreck. The work was greatly delayed by unfavorable weather. It was completed March 31, 1890. Mr. G. F. Rostock was local inspector.

Abstract of proposals for removing wreck of schooner Sarah L. Simmons, received at Engineer Office, U. S. Army, Newport, R. I., in response to advertisement dated October 21, 1889, and opened at 12 o'clock, noon, on Thursday the 21st day of November, 1889.

No.	Name and address of bidder.	Amount of bid.
1	Alexander Crocker, Hyannis, Mass	$3,848
2	Wm. E. Chapman, New York, N. Y	3,960

Contract awarded to Alexander Crocker, of Hyannis, Mass., with the approval of the Chief of Engineers, and dated December 11, 1889.

Work to be commenced within 10 days after the approval of the contract by the Chief of Engineers, and completed within 30 days of the time of commencement.

WRECK OF SCHOONER ELLEN R.

The schooner *Ellen R.* was wrecked some time during the year 1888, in Little Harbor, Wood's Holl, Mass. Her dimensions were approximately as follows: Length, 53 feet; breadth, 18 feet; tonnage, 25. The name of her owner, or the circumstances attending her loss, were not ascertained.

The notice required by section 4 of the river and harbor appropriation act of June 14, 1880, to all persons interested in the vessel, etc., was given by advertisement in newspapers, and proposals for removing the wreck were invited. No action having been taken by the owners, the proposals were opened January 13, 1890.

An abstract of the proposals received and the terms of the contract will be found in the appended table.

The contractor finished the removal of the wreck March 26, 1890. Mr. A. R. Elliott was local inspector of the work.

Abstract of proposals for removing wreck of schooner Ellen R., received at Engineer's Office, U. S. Army, Newport, R. I., in response to advertisement dated December 13, 1889, *and opened at* 12 *o'clock, noon, on Monday the* 13*th day of January*, 1890.

No.	Name and address of bidder.	Amount of bids.
1	Charles E. Davis, Wood's Holl, Mass	$189
2	William Buckley, Vineyard Haven, Mass	284
3	James Baker, Boston, Mass	787

Contract awarded to Charles E. Davis, of Wood's Holl, Mass., with the approval of the Chief of Engineers, and dated January 23, 1890.

Work to be commenced within ten days after the approval of the contract by the Chief of Engineers, and completed within thirty days of the time of commencement.

WRECK OF SCHOONER QUILP.

The schooner *Quilp* was wrecked on the north side of the entrance to Cuttyhunk Pond, Cuttyhunk Island, Massachusetts. The vessel was built at Mystic Conn., in 1861, and was 39 feet long. Her gross tonnage was 15.98.

The notice required by section 4 of the river and harbor appropriation act of June 14, 1880, to all persons interested in the vessel, etc., was given by advertisement in newspapers, and proposals for removing the wreck were invited. No action having been taken by the owners, the proposals were opened February 17, 1890.

An abstract of the proposals received and the terms of the contract will be found in the appended table.

The contractor finished the removal of the wreck March 24, 1890. Mr. A. R. Elliot was the local inspector.

Abstract of proposals for removing wreck of schooner Quilp, received at Engineer's Office, U. S. Army, Newport, R. I., in response to advertisement dated January 17, 1890, *and opened at* 12 *o'clock, noon, on Monday the* 17*th day of February*, 1890.

No.	Name and address of bidder.	Amount of bid.
1	William Buckley, Vineyard Haven, Mass	$164
2	Charles E. Davis, Wood's Holl, Mass	189
3	John J Veeder, Wood's Holl, Mass	195
4	Timothy Akin, sr., Cuttyhunk, Mass	195
5	C. C. Allen, New Bedford, Mass	198

Contract awarded to William Buckley, of Vineyard Haven, Mass., with the approval of the Chief of Engineers, and dated February 28, 1890.

Work to be commenced within ten days after the approval of the contract by the Chief of Engineers, and completed within thirty days of the time of commencement.

WRECK OF SCHOONER BENJAMIN GARTSIDE.

The schooner *Benjamin Gartside* was loaded with about 450 tons of coal and was bound from Hoboken, N. J., to East Cambridge, Mass. On October 5, 1889, while lying at anchor about 2½ miles northwest one-half west from Handkerchief Light-Ship, she was struck amidships by the schooner *Mary B. Wellington* and sank in about 29 feet of water, constituting a dangerous obstruction to navigation of the north channel of Vineyard Sound. She was owed by Bartlett & Shepherd, of Philadelphia, Pa., and was built at Chester, Pa., in 1869. Her dimensions were approximately as follows: Gross tonnage, 343.33; length, 130.9 feet; breadth, 29.2 feet; depth, 13.7 feet. She was stripped of her sails, booms, gaffs, and running gear by wreckers.

The notice required by section 4 of the river and harbor appropriation act of June 14, 1880, to all persons interested in the vessel, etc., was given by advertisement in newspapers, and proposals for removing the wreck were invited. No action having been taken by the owners the proposals were opened May 22, 1890.

An abstract of the proposals received and the terms of the contract will be found in the appended table.

The work of removal of the wreck was commenced June 18, 1890, and was in progress at the close of the year. Mr. G. F. Rostock is the local inspector.

Abstract of proposals for removing wreck of schooner Benjamin Gartside, received at Engineer Office of U. S. Army, Newport, R. I., in response to advertisement dated April 22, 1890, and opened at 12 o'clock noon, on Thursday, the 22d day of May, 1890.

No.	Name and address of bidder.	Amount of bid.
1	Geo. W. Townsend, Boston, Mass	$2,949
2	James Baker, Boston, Mass	3,733
3	Wm. E. Chapman, Brooklyn, N. Y	3,843
4	Chas. E. Davis, Wood's Holl, Mass	4,875

Contract awarded to Geo. W. Townsend, of Boston, Mass., with the approval of the Chief of Engineers, and dated June 4, 1890.

Work to be commenced within ten days after the approval of the contract by the Chief of Engineers, and completed within 30 days of the time of commencement.

C 16.

PRELIMINARY EXAMINATION OF MARTHA'S VINEYARD, INNER AND OUTER HARBOR AT EDGARTOWN, MASSACHUSETTS.

ENGINEER OFFICE, U. S. ARMY,
Newport, R. I., December 14, 1888.

GENERAL: In compliance with instructions contained in Department letter of September 29, 1888, I have the honor to submit the following report upon the preliminary examination of Martha's Vineyard,

inner and outer harbor at Edgartown, Mass., provided for in the river and harbor act of August 11, 1888, and made by Maj. W. R. Livermore, Corps of Engineers, and Mr. Edward Parrish, assistant engineer, September 20 to 22 last.

The outer harbor referred to lies to the north and east of Edgartown, Martha's Vineyard. It is bounded on the east by Chappequiddick Island and on the west by a shoal extending northward from Edgartown light for a distance of about 3 miles.

The deep-water area of this harbor is about 3 miles in length from north to south, about 1 mile in width, and is sheltered from all storms except those from the north.

The inner harbor is formed by the channel that separates Chappequiddick Island from Martha's Vineyard, and has an area of about three-fourths of a square mile. It is connected with the outer harbor by an opening 350 feet wide.

The improvement desired in the outer harbor is the construction of a breakwater to protect the anchorage area from northerly storms, that in the inner harbor the removal of a shoal known as the Middle Ground extending southerly from Chappequiddick Point.

The extent of the commerce passing this point is well known and has been fully reported by General Warren and especially by Colonel Elliot in his report on the examination of Vineyard Haven, which may be found in the annual report for 1887, pages 572–580.

The general track of vessels passing through Nantucket Sound lies about 5 miles to the northward of Edgartown, at which point they can find an anchorage well protected from all storms excepting those from the north.

A harbor of refuge especially for the smaller class of vessels is quite desirable there.

It is roughly estimated that for $150,000 a breakwater could be built about 1 mile northeast of Edgartown, affording an anchorage area of about one-half square mile in the outer harbor, and by dredging the Middle Ground in the inner harbor to a depth of 12 feet an additional area of about one-fourth square mile would be available for smaller vessels.

The cost of this dredging is roughly estimated at $8,000.

In my opinion the inner and outer harbor of Edgartown are worthy of improvement by the General Government, and the cost of a survey of the locality is estimated at $400.

Commercial statistics are appended hereto, and a coast-survey chart of Edgartown, showing the location of the proposed improvement, is herewith inclosed.

Edgartown is in the Edgartown collection district and is a port of entry. The amount of revenue collected there during the last fiscal year is unknown. The nearest light-house is the Edgartown Light; the nearest fortification is the fort at Clark's Point, New Bedford, Mass. The population of Edgartown by the United States census of 1880 was 1,303.

Very respectfully, your obedient servant,

W. R. LIVERMORE,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

COMMERCIAL STATISTICS.

[Furnished by Mr. Walter S. Osborn.]

Estimated number of arrivals at port of Edgartown annually.

Sail, coasting vessels	900
Sail, fishing vessels	200
Steam tugs, yachts, and miscellaneous	100
Whaling vessels	2

Value of sperm oil taken by vessels owned here, past year, $44,000.

Estimated amount of imports annually.

Sperm oil	$10,000
Coal	15,000
Lumber	4,000
Grain	10,000

Estimated amount of exports annually.

Sperm oil	$10,000
Fish	$20,000
Number of vessels owned in district of Edgartown	30
Number of whaling vessels fitted and sailed from Edgartown since 1872	30
Number of men employed on each	30

Number of whaling vessels owned here, 4. Aggregate tonnage, 600 tons.

New Bedford, Martha's Vineyard, and Nantucket steamers make a terminus at this port for nine months of the year.

SURVEY OF MARTHA'S VINEYARD, INNER AND OUTER HARBOR AT EDGARTOWN, MASSACHUSETTS.

ENGINEER OFFICE, U. S. ARMY,
Newport, R. I., December 6, 1889.

GENERAL: In compliance with instructions contained in Department letter of April 1, 1889, I have the honor to make the following report of survey of Martha's Vineyard, inner and outer harbors at Edgartown, Mass.

This survey was completed on the 26th day of September.

A report of the preliminary examinations of these harbors was submitted December 14, 1888.

They are located in the eastern part of Martha's Vineyard Island, Massachusetts.

The *inner harbor* lies in the northern part of the water-way or strait that separates Chappaquiddick Island from Martha's Vineyard; it extends southward about 1½ miles from Chappaquiddick Point opposite Edgartown and averages about one-fifth of a mile in width.

The contracted width to the entrance to this harbor taken in connection with the resulting tidal currents of great velocity makes it difficult for vessels to enter and leave the inner harbor, which is too contracted to form a sufficient harbor of refuge, for, owing to its limited width, vessels lying farthest from the entrance would be detained until after the departure of those lying close to it or until southerly winds should favor a straight course to the entrance.

On the other hand, the inner harbor is so completely land-locked that vessels often seek refuge here; it is also needed for the accommodation of vessels receiving and discharging their cargoes, but the commercial

importance of Edgartown is not such as to justify any expenditure of money on the latter score. As it is proposed to protect the outer harbor by a breakwater it is only the interest of vessels of light draught which need be considered here.

The anchorage area for vessels of this class would be materially improved by removing the middle ground to a depth of 10 feet below mean low water, as shown on the accompanying map "A."

A comparison of the results of the survey made under the direction of Maj. G. K. Warren, in the month of August, 1874, with those of the survey just completed, indicates an increased depth on the middle ground in the inner harbor, also in the channel south of the light-house and on the shoal that extends out towards Buoy No. 10; this increase varies from 1 to 3 feet.

The borings taken on the middle ground show that it is composed of sand for about 3 feet from the surface; below this depth it appears to be composed of coarse gravel or hard pan.

To remove this shoal would require an excavation of 18,000 yards of material, at a cost of 25 cents per yard, making $4,500; all of this could be expended in one year advantageously.

The *outer harbor* lies to the north and east of Edgartown, and is bounded by Chappaquiddick Island on the east and south and on the west by a shoal that extends northward from the harbor light-house. It is about 3 miles in its greatest length measured in a direction from NNE. to SSW., and about 1 mile in width.

The natural conditions here offer sufficient protection from all storms except those from the NNE. to NW. In winter, however, the large quantity of ice that forms on the shoal to the west and northwest of the harbor is driven into it by northwesterly winds.

The parties desiring the improvement of Edgartown harbors state in their petition to Congress: * * * "There is now no safe and suitable harbor of refuge of sufficient size and contiguous to the route ordinarily taken by said vessels so that said vessels in case of severe storms may have a safe anchorage," * * * and "pray that such a harbor of refuge may be established at the port of Edgartown by the construction of a breakwater extending from near Stony Point, Cape Pogue, about 1 mile, more or less, in about northwesterly direction." * * *

While the statement that there is no harbor of refuge protected on all sides from storms is true, the construction of such a harbor for all classes of vessels passing through the Vineyard and Nantucket sounds is one involving the consideration of other sites than that of Edgartown, and until some site is selected for a large harbor and due consideration given to the various localities presenting facilities for the purpose it is, in my opinion, of more pressing importance to provide harbors for the smaller class of vessels than the larger ones, as the latter can lie at anchor in localities that are partially protected with much less risk of disaster.

The outer harbor of Edgartown presents a locality in which the smaller class can be so protected by the construction of an ice-breaker extending out from the light-house in a northeasterly direction, and a breakwater in the position shown on the accompanying map "A."

The ice-breaker here proposed is of the following cross-section: Four feet wide on the top, which is at an elevation of 8 feet above mean low water. The slopes on that part lying between the shore and the 6-foot curve are similar to those used in the eastern jetty at Nantucket, viz, 1 *on 1.* For the outer portion in more than 6 feet of water the slopes are

made 1 on 2 on the sea side and 1 on 1 on the harbor side to the depth of 12 feet below mean low water; below this they are made 1 on 1.

The cross-section of the breakwater is the same as that for the outer portion of the ice-breaker. The estimated cost of this improvement is as follows:

Ice-breaker, 23,000 tons riprap granite, at $1	$23,000
Breakwater, 65,000 tons riprap granite, at $1	65,000
Contingencies	8,000
Total	96,800

The amount that could be profitably expended in one year is $50,000.

The subject of a suitable harbor of refuge in these sounds is one that has been called to the attention of the General Government from time to time since 1826, when the first survey for such a harbor was made at Great Point, Nantucket.

The Vineyard and Nantucket sounds, with perhaps one or two exceptions, form the greatest thoroughfare in the world, and that its passage is one often attended with danger is attested by the numerous wrecks that have occured in its waters.

The locality that presents the most favorable natural features for the establishment of a harbor of refuge for the large vessels lies to the north of Edgartown and to the eastward of Vineyard Haven Harbor, and includes that portion of the sound lying between Squash Meadow Shoal and the shore of Martha's Vineyard from Cottage City to Edgartown. The site of a breakwater to protect this anchorage area would be mainly on Squash Meadow Shoal.

The breakwater would extend out from the shore near Cottage City for a distance of 3,300 feet to a point about 4,000 feet from the western end of the shoal, thence the entire length of the shoal, bending to the southward near its eastern end, protecting an area from all winds from the east to the north. The length of this portion of the breakwater would be about 13,000 feet.

The cross-section required for a breakwater in this locality would be 15 feet wide on the top, which would be 8 feet above mean low water, with slopes of 1 on 1 and 1 on 2 to a depth of 12 feet below mean low water; below this the slopes would be 1 on 1.

The estimated cost of such a structure is $1,880,000; $300,000 could be advantageously expended in one year.

The accompanying map* marked "A" is made from the survey of the inner and outer harbors at Edgartown, completed last September, and shows the proposed lines for the ice-breaker and breakwater in the outer harbor, together with their cross-sections and the area to be dredged in the inner harbor.

The map* marked "B" is from the Coast Survey chart, on a scale $\frac{1}{80000}$ showing the location of a breakwater on Squash Meadow Shoal.

Very respectfully, your obedient servant,

W. R. LIVERMORE,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

* Omitted; printed in House Ex. Doc. No. 59, Fifty-first Congress, first session.

C 17.

PRELIMINARY EXAMINATION OF COVE NEAR SOUTHEAST EXTREMITY OF COASTER'S HARBOR ISLAND AND WATER-WAY BETWEEN SAID ISLAND AND RHODE ISLAND, WITH A VIEW TO DEEPENING THE WATER-WAY AND REMOVING OBSTRUCTIONS.

ENGINEER OFFICE, U. S. ARMY,
Newport, R. I., December 14, 1888.

GENERAL: In compliance with instructions contained in Department letter of September 29, 1888, I have the honor to submit the following report upon the preliminary examination of cove near southeast extremity of Coasters' Harbor Island and water-way between said island and Rhode Island, provided for in the river and harbor act of August 11, 1888, and made by me frequently in August and September last.

This cove and water-way, situated in the northwestern part of the city of Newport, Newport County, R. I., at the southeastern extremity of Coaster's Harbor Island, are used by the United States Navy as a training station. The old 74-gun ship *New Hampshire* is permanently anchored at the southeast point of the island.

I am informed by Commander Higginson, United States Navy, in command of the training station, that the improvements desired are to have the cove deepened at a point near the causeway which forms its northern boundary, at least enough to afford a berth for the *Saratoga*, or a vessel of that class, and to dredge a channel leading to it from the harbor, utilizing the dredged material for building up the island, also to have the water-way between Coaster's Island and Rhode Island deepened so that the flow of water through it will be sufficient to carry off all the garbage, etc., that it is thrown from the training-ship, and which if allowed to accumulate would in time not only cause sickness on the ship, but to the residents of the adjacent country. The water-way is now crossed by a causeway having only one opening and in consequence is rapidly filling up.

In my opinion the cove is worthy of improvement by the General Government, and perhaps something might be done to improve the water-way.

The cost of dredging the cove is roughly estimated at $5,000, and in the water-way from $5,000 to $15,000. The cost of a survey of the locality is estimated at $200. A sketch* of the cove and water-way showing the location of the proposed improvement is herewith inclosed.

Coaster's Harbor Island is in the collection district of Newport, which is a port of entry. The amount of revenue collected at Newport in the last fiscal year was $2,184.51. The nearest light-house is Gull Rock Light. The nearest fortification is Fort Adams, Newport, R. I. The population of Newport by the State census of 1885 was 19,556.

Very respectfully, your obedient servant,

W. R. LIVERMORE,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

---

* Not printed.

SURVEY OF COVE NEAR SOUTHEAST EXTREMITY OF COASTER'S HARBOR ISLAND AND WATER-WAY BETWEEN SAID ISLAND AND RHODE ISLAND, WITH A VIEW TO DEEPENING THE WATER-WAY AND REMOVING OBSTRUCTIONS.

ENGINEER OFFICE, U. S. ARMY,
Newport, R. I., December 6, 1889.

GENERAL: In compliance with Department letter of April 1, 1889, I have the honor to submit the following report of survey of cove near southeast extremity of Coaster's Harbor Island and water-way between said island and Rhode Island. My report of the preliminary examination of this cove and water-way was submitted December 14, 1888, accompanied by a sketch showing the location of Coaster's Harbor and the water-way, with reference to Newport and the adjacent islands.

They are situated in the northwestern part of the city of Newport, Newport County, R. I. A causeway connecting Coaster's Harbor Island with Rhode Island, forms the northern boundary of the cove and separates it from the water-way above. This causeway having but one small opening has checked the flow of water around the island and caused deposits, which have filled up the water-way so that the bottom is exposed at low tide, and the eel-grass and decomposed vegetable matter, with which it is covered impregnate the atmosphere with disagreeable and unhealthy odors.

The United States naval training station is located here, and until recently the training-ship *New Hampshire* was anchored in the cove at the southeastern extremity of Coaster's Harbor Island. The refuse from this vessel has remained in the cove, and on account of sickness and death the *New Hampshire* has been removed to the deep water south of the island and the apprentices are quartered on the island.

The improvement desired is to deepen the anchorage area in the cove and to increase the flow of water around the island.

PROJECT.

It is proposed to make two additional openings in the causeway, each 60 feet wide, spanned by wooden bridges 30 feet long resting on stone piers. It is understood that in the future training vessels manned with their full crews will not be permanently anchored in the cove.

The cost of this improvement is estimated as follows:

Making openings and constructing bridges	$3,000
Dredging	2,000
	5,000
Contingencies 10 per cent	500
Total	5,500

The area to be dredged and the approximate position of the proposed openings in the causeway are indicated on the accompanying map * of the recent survey by parallel lines.

Very respectfully, your obedient servant,

W. R. LIVERMORE,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

* Omitted; printed in House Ex. Doc. No. 63, Fifty-first Congress, first session.

C 18.

PRELIMINARY EXAMINATION OF COAST NEAR LIFE-SAVING STATION, EAST POINT JUDITH, RHODE ISLAND, WITH A VIEW TO CONSTRUCTING A BREAKWATER.

ENGINEER OFFICE, U. S. ARMY,
Newport, R. I., December 14, 1888.

GENERAL: In compliance with instructions contained in Department letter of September 29, 1888, I have the honor to submit the following report upon the preliminary examination of coast near life-saving station, East Point Judith, Rhode Island, provided for in river and harbor act of August 11, 1888, and made by Capt. Thos. L. Casey, Corps of Engineers, on the 11th of October last.

Point Judith is the southeastern extremity of South Kingstown Township, Washington County, R. I., and marks the southwestern entrance to Narragansett Bay.

Captain Casey recommends the establishment of a harbor of refuge in this locality. His report is accompanied by two sketches * and a list of vessels which have been wrecked there between 1883 and 1888. I have been told that the loss of the largest of these vessels was caused by fogs and not by storms. The amount of commerce passing Point Judith is too well known to require detailed description. The point is an exceedingly dangerous one to navigation. While vessels of large size can ride in the trough of the sea to a safe shelter in Narragansett Bay, a harbor of refuge for smaller vessels is much needed here.

Such a harbor can be established by the construction of breakwaters, at a cost, roughly estimated, of $300,000, which would also afford relief to the commerce of the neighboring villages, and furnish a landing for the boats of the Point Judith life-saving service, which now often can not be effected nearer than Newport or Block Island. I am therefore of the opinion that East Point Judith is worthy of improvement by the General Government, and estimate the cost of a survey of the locality at $300.

Point Judith is in the collection district of Newport, which is a port of entry. The amount of revenue collected at Newport in the last fiscal year was $2,184.51. The nearest light-house is Point Judith Light. The nearest fortification is the fort on Dutch Island, Rhode Island. The population of South Kingstown by the Rhode Island State census of 1885 was 5,549.

Captain Casey's report is herewith inclosed.

Very respectfully, your obedient servant,

W. R. LIVERMORE,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. Army.

REPORT OF CAPTAIN THOMAS L. CASEY, CORPS OF ENGINEERS.

ENGINEER OFFICE, U. S. ARMY,
Newport, R. I., October 12, 1888.

SIR: The following is a report of the preliminary examination of Point Judith Pond and the coast line thence to Point Judith, Rhode Island, with a view to the establishment of harbors of refuge.

* Not printed.

On the morning of October 11 the party set out from the upper end of the upper pond in a small steam-launch belonging to Mr. Jeremiah P. Robinson and brother, of Wakefield. A sounding-rod had been provided graduated to feet. Soundings were taken at intervals of about a fifth of a mile. The course lay down the upper pond to the Narrows, thence in a nearly straight course to the interval between Gardiner's Island and a smaller island lying immediately to the eastward, and thence in a gentle curve to High Point.

As indicated on the accompanying map the soundings taken show that from the upper end of the pond to a point nearly opposite Buf Island, a distance of about 2 miles, a channel depth of about 10 feet can easily be obtained, but from the latter point to the entrance the depth became rapidly less, and, in order to obtain sufficient depth of water for commercial purposes, extensive dredging will be necessary.

At a point about one-half mile below High Point the party left the launch because of the eel-grass which impeded the propeller, and took to a flat-bottom skiff. As we approached the entrance along the dotted line on the map it could be seen that there was a preceptible current setting into the pond and into the narrow passage forming its outlet; this current became so strong that headway could be made with difficulty against it. The depth in the narrow tortuous outlet varied from 3 to 8 feet. The tide was at its full, and there was no appearance of a bar at the entrance. As the mean range of the tide on the coast is about 3 feet, and as the known range of the tide in the pond is from 6 to 9 inches, it follows that the low level of the pond can not be much more than 2.5 feet above mean low tide in the ocean, and that if a navigable channel 200 feet wide and 7 feet deep (at midtide) was excavated as indicated on the diagram marked A, the depth in the pond would be reduced by that amount at low tide. By a rough calculation, assuming the area of the pond to be 1½ square miles, such an outlet as that just indicated would accommodate the incoming and outflowing tide with a current of 3 miles per hour. If a row of guide-piling sheathed with planks be driven along the borders of the artificial channel and cut off at a height of 8 feet above the high-water level, it would serve to retain the current for purposes of deepening the channel, and would at the same time serve as a catch for the loose sand which is sometimes extensively shifted by the wind.

If a harbor of refuge is to be built on the coast to the westward of Point Judith, it would seem that the best location for it would be at the entrance of this pond, where it would serve at once as a harbor of refuge and as a quiet port wherein vessels might discharge cargoes upon lighters, which could then be towed up the pond to Wakefield.

There is no part of the coast between the entrance and Point Judith which could be advantageously chosen as a site for the harbor, because of a long ledge which extends for nearly a mile in a south by easterly direction from a point nearly one-half mile from the shore near the entrance of the pond. This ledge would effectually bar the progress of any vessel drawing more than 13 feet of water, and its attempt to reach such a harbor from the southwest would at all times be dangerous.

The position of the proposed harbor is indicated on the map.

Proceeding to the life-saving station at Point Judith, the captain of the crew was asked his opinion as to the position and nature of the proposed breakwater to the north of the point. The position of the breakwater as traced by him is shown on the map, and it was suggested that a small prolongation at right angles to the axis and from its extremity would be very useful, and such a form far superior to the arc of a circle.

If the breakwater be built in this position, it is suggested that it be capped with large, rough-finished stones, so that it could serve some of the purposes of a dock.

On reviewing the entire project, which, although threefold in its nature, is in reality only one, it should be said in conclusion that it is quite possible, and, as far as the Wakefield harbor of refuge and the Point Judith breakwater are concerned, almost a necessity.

Appended (marked B) there is a list of the vessels which have been wrecked on this coast from the Point Judith Pond Inlet to a point midway between the point and Narragansett Pier. It was very obligingly furnished by the captain of the life-saving crew.

Very respectfully, your obedient servant,

THOS. L. CASEY,
Captain of Engineers.

Maj. W. R. LIVERMORE,
Corps of Engineers, U. S. A.

List of vessels wrecked near Point Judith, 1883–'88.

Names wrecked.	When wrecked.	Valuation of vessels.	Valuation of cargo.	Nature.
Schooner Warren Gates	Mar. 25, 1883	$4,000	$6,500	Steel wire.
Schooner Thomas R. Pillsbury	June 13, 1883	28,000	2,500	Coal.
Schooner Julia A. Tate	May 10, 1884	4,000	3,500	Logwood and axles.
Schooner Idlewild	June 6, 1884	2,000	1,125	Grain.
Schooner Almond Bacon	Nov. 5, 1885	3,000	2,000	Iron.
Schooner Mott Haven	Dec. 25, 1885	6,000	1,900	Furniture and oil.
Schooner Willie De Wolf	do	3,000	1,500	Lumber.
Schooner Allen Greene	Jan. 9, 1886	12,000	No cargo.	Ballast.
Steamer Miranda	June 20, 1886	110,000	$31,500	General cargo.
Schooner Mary Natt	Dec. 1, 1886	1,200	2,700	Iron.
Schooner Harry A. Barry	Feb. 20, 1887	25,000	4,275	Coal.
Schooner Mary A. Drury	Dec. 31, 1887	10,000	2,000	Do.
Brig John Welsh, jr.	Mar. 3, 1888	1,500	1,200	Do.
Schooner Maggie J. Smith	Nov. 10, 1887	35,000	5,000	Do.
Schooner Henry H. Olds	Apr. 12, 1888	45,000	5,000	Do.
Schooner Anita	May 2, 1888	3,000	1,800	Lumber.
Schooner Earl P. Mason	Aug. 22, 1888	17,000	3,000	Coal.
Schooner Isaac H. Borden	Sept. 9, 1888	500	3,000	Oil.
Total number wrecks, 18; total valuation		310,200	78,500	

SURVEY OF COAST NEAR LIFE-SAVING STATION, EAST POINT JUDITH, RHODE ISLAND, WITH A VIEW TO CONTRUCTING A BREAKWATER.

ENGINEER OFFICE, U. S. ARMY,
Newport, R. I., December 6, 1889.

GENERAL: In compliance with instructions contained in Department letter of April 1, 1889, I have the honor to make the following report of a survey of the coast near life-saving station, East Point Judith, Rhode Island. This survey was completed in the month of July. A report of the preliminary examination of the coast was submitted December 14, 1888.

Point Judith is the southeastern extremity of South Kingston, Washington County, R. I., and marks the southwestern entrance to Narragansett Bay. Its shores are covered with bowlders, and the remains of a number of wrecks are scattered along the beach on both sides of the point.

The ebb tides from Narragansett Bay, Long Island Sound, and Buzzard's Bay meet southeast of here, and when a heavy wind is blowing from that quarter the smaller class of vessels do not attempt to pass the point; those east of it run into either Newport or Dutch Island harbors, a distance of 12 or 15 miles, while those west of it run for Stonington, Conn., distant 21 miles. The amount of commerce passing this point is considerable, but the larger vessels engaged in the coasting trade pass to the southward of Block Island, only about 10 miles distant, where in heavy storms they lie under the lee of its shores.

In my report of the preliminary examination of the coast near life-saving station, East Point Judith, Rhode Island, I stated that a harbor could be made by building breakwaters at a cost, roughly estimated, at $300,000. Subsequent examination, however, shows that such a harbor could not answer the requirements. A small area could be protected at a considerable cost, but the anchorage would not be good.

Although an examination of the coast immediately west of the point was not required by the act of Congress of August 11, 1888, the survey was extended as far to the westward as the funds would allow. The results of this survey and examination indicate that a harbor could be

built here for about $1,250,000 that would be large enough for small vessels, but the bottom is hard and sandy and the current strong.

The position of the breakwater is shown on the sketch.*

The following is the estimated cost of breakwater at Point Judith:

1,100,000 tons of riprap granite, at $1	$1,100,000
Contingencies	150,000
Total	1,250,000

Very respectfully, your obedient servant,

W. R. LIVERMORE,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

C 19.

PRELIMINARY EXAMINATION OF NARRAGANSETT BAY AT THE MOUTH OF NARROW RIVER, RHODE ISLAND, WITH A VIEW OF CONSTRUCTING A BREAKWATER.

ENGINEER OFFICE, U. S. ARMY,
Newport, R. I., December 14, 1888.

GENERAL: In compliance with instructions contained in Department letter of September 29, 1888, I have the honor to submit the following report upon the preliminary examination of Narragansett Bay at the mouth of Narrow River, Rhode Island, provided for in the river and harbor act of August 11, 1888, and made by me on the 8th October last.

Narrow River empties into the western side of Narragansett Bay about 6 miles above Point Judith and about 1¼ miles northeast of Narragansett Pier. It is in South Kingston, Washington County, R. I. It connects the waters of Pataquamset River and a cove of the same name with Narragansett Bay.

The former is navigable for small vessels for a distance of about 5 miles to the northward of its junction with Narrow River about three-fourths of a mile from the mouth of the latter. The cove extends to the southward about 1¼ miles and is navigable for flat-boats.

These bodies of water form tidal reservoirs which tend to scour the bottom of Narrow River, the waters from which carry comparatively little sediment. Such shoaling as occurs at the mouth of the river is probably occasioned by the wash of sand from the beach to the southward.

The parties desiring the improvement ask for the construction of a breakwater extending from the beach below the mouth of Narrow River, first in a southeasterly direction for a distance of about 1,200 feet, thence northeasterly about 300 feet, for the purpose of stopping the movement of the sand along the beach into the mouth of the river. They also propose to build a line of railroad from this harbor to Narragansett Pier, about 1¼ miles to the southward, and wharves for landing within the harbor.

The present landing at Narragansett Pier is not available in bad

* Omitted; printed in House Ex. Doc. No. 66, Fifty-first Congress, first session.

weather, as it is unprotected from the sea, and there is no other landing in the vicinity. It is also controlled by private parties.

The shores in the vicinity are bold and rocky, except to the south, where they are high and cultivated, the sand being protected from the wind by sod.

It is stated that the cost of fuel and building material would be reduced from one-fourth to one-third by the establishment of a harbor wherein vessels could load and unload in safety, and that about 8,000 to 9,000 inhabitants would be benefited by the improvement, both in cheapening the cost of living and facilitating the shipment of their products.

A rough estimate of the cost of a breakwater here is $30,000. I am of opinion that Narragansett Bay at the mouth of Narrow River is worthy of improvement by the General Government, and I estimate the cost of a survey of the locality at $300.

Narrow River is in the collection district of Newport, which is a port of entry. The amount of revenue collected at Newport in the last fiscal year was $2,184.51. The nearest light-house is Whale Rock Light. The nearest fortification is the fort on Dutch Island, Rhode Island. The population of South Kingstown, by the Rhode Island State census of 1885, was 5,549, and that of North Kingstown was 3,874.

Commercial statistics are hereto appended, and a sketch* showing location of the proposed improvement and one of the neighboring country are herewith inclosed.

Very respectfully, your obedient servant,

W. R. LIVERMORE,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

COMMERCIAL STATISTICS.

[Furnished by Mr. George N. Kenyon.]

Material landed at Narragansett Pier from June 1, 1887, *to October* 15, 1888.

Coal	tons	11,906
Brick	number	481,000
Corn	bushels	28,800
Cement	tons	225
Lime	barrels	1,829
Lumber	feet	3,295,000
Shingles	number	1,159,000
Laths	do	1,119,000
Railroad iron	tons	200
Water-pipe	do	220
Oyster-shells	do	220

Besides twelve cargoes containing general merchandise, blue-stone, railroad-ties, etc.

SURVEY OF NARRAGANSETT BAY AT THE MOUTH OF NARROW RIVER, RHODE ISLAND, WITH A VIEW OF CONSTRUCTING A BREAKWATER.

ENGINEER OFFICE, U. S. ARMY,
Newport, R. I., December 6, 1889.

GENERAL: I have the honor to make the following report of survey at the mouth of Narrow River, Rhode Island, a report of the preliminary examination of which was made December 14, 1888.

*Not printed.

Department letter of April 1, 1889, notified me that an allotment had been made to defray the expenses of surveys in this district, and as soon thereafter as possible they were commenced. Heavy seas and dense fogs delayed the completion of the survey at this place until the end of June.

Narrow River is about three-quarters of a mile long, and lies in the eastern part of South Kingstown, Washinton County, R. I.,* about 6 miles above Point Judith, and acting as an outlet for the waters of Pettaquamscott River and cove, empties into Narragansett Bay at a point about 1¼ miles northeast of Narragansett Pier, a town of considerable importance as a summer watering place. A sandy beach extends from this town northward to the mouth of Narrow River, where the west shore of Narragansett Bay suddenly becomes bold and rocky. Granite of good quality has been quarried from a ledge on the north bank of the river. This ledge serves to protect the entrance to the river from northeast storms, while those from the south carry the sand northward and contract the mouth of the river.

It is thought by those who desire the improvement that a breakwater extending out from a point on the beach south of the entrance will stop the movement of this sand and will afford a sufficient area of smooth water to enable vessels to receive and discharge their cargoes.

Narrow River and its main branch, the Pettaquamscott River, are navigable for about 5¾ miles above the mouth of the former; the cove is navigable for flat-boats.

The estimated cost of a breakwater, the position of which is shown on the accompanying map,† marked "A," is $24,000. No further expenditure is recommended, as any improvement here is of doubtful permanence on account of the shifting sand. The requirements of this locality can never demand an extensive harbor, inasmuch as one more than a hundred times as large could be made a few miles to the northward, as shown on the accompanying map,† marked "B," by constructing on the south, at the point marked "*a*," a breakwater at a cost of $150,000, and later, if found necessary, on the north, at the point marked "*b*," another, at a cost of $75,000. This would form one of the most perfect sea-ports in the Northern States, far superior in all respects to Providence, Newport, or Fort Pond at the eastern end of Long Island.

The following is the estimated cost of breakwater at Narrow River:

44,000 tons of rip-rap granite, at 50 cents	$22,000
Contingencies	2,000
Total	24,000

Very respectfully, your obedient servant,

W. R. LIVERMORE,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

* It is understood that a district called Narragansett has recently been formed embracing the eastern part of this town.

† Omitted; printed in House Ex. Doc. No. 57 Fifty-first Congress, first session.

APPENDIX D.

IMPROVEMENT OF CONNECTICUT RIVER, MASSACHUSETTS AND CONNECTICUT, AND OF RIVERS AND HARBORS ON LONG ISLAND SOUND, CONNECTICUT, AND NEW YORK.

REPORT OF COL. D. C. HOUSTON, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1890, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Thames River, Connecticut.
2. New London Harbor, Connecticut.
3. Connecticut River, Massachusetts and Connecticut.
4. Clinton Harbor, Connecticut.
5. New Haven Harbor, Connecticut.
6. Breakwater at New Haven, Connecticut.
7. Milford Harbor, Connecticut.
8. Housatonic River, Connecticut.
9. Bridgeport Harbor, Connecticut.
10. Black Rock Harbor, Connecticut.
11. Norwalk Harbor, Connecticut.
12. Five Mile River Harbor, Connecticut.
13. Stamford Harbor, Connecticut.
14. Port Chester Harbor, New York.
15. Echo Harbor, New Rochelle, New York.
16. New Rochelle Harbor, New York.
17. East Chester Creek, New York.
18. Greenport Harbor, New York.
19. Glen Cove Harbor, New York.
20. Flushing Bay, New York.
21. Removing sunken vessels, or craft, obstructing or endangering navigation.

EXAMINATIONS AND SURVEYS.

22. Brown's Creek, Sayville, New York.
23. Larchmont Harbor, New York.

HARBOR LINES.

24. Establishment of harbor lines at Stamford Harbor, Connecticut.

ENGINEER OFFICE, U. S. ARMY,
New York, July 8, 1890.

GENERAL: I have the honor to transmit herewith the annual report upon the works of river and harbor improvement under my charge for the fiscal year ending June 30, 1890.

Very respectfully, your obedient servant,

D. C. HOUSTON,
Colonel of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

D 1.

IMPROVEMENT OF THAMES RIVER, CONNECTICUT.

This river is formed by the confluence of the Yantic and Shetucket rivers, at Norwich, Conn., and extends southward as a tidal stream 15 miles to Long Island Sound. For 11 miles above its mouth the channel is from 13 to 80 feet deep, averaging over 30 feet for the first 4 miles. For 3 miles below Norwich, the available depth in 1829 was but 6 feet at mean low water, where now there is 11 feet. Histories of the improvements may be found in the Annual Report of the Chief of Engineers for 1873, page 981, and in that for 1879, part 1, page 331.

PROJECTS FOR IMPROVEMENT.

Prior to 1830 various attempts had been made by private parties or corporations to deepen the channel of this river near Norwich; the first ones were by excavation only, but subsequently stone piers were constructed perpendicular to the channel at shoal spots.

By act of March 2, 1829, Congress appropriated $150 "for making a survey of the river Thames with a view to improve the navigation of the same, and the cost of such improvement."

The survey was made in 1829 by Capt. Hartman Bache, Corps of Engineers. At that time there were four old piers standing. In his report upon the survey, dated February 20, 1830, and printed in House of Representatives War Department Document, No. 125, Twenty-first Congress, first session, Captain Bache submitted a project for making a channel 60 feet wide, to be either 12 or 14 feet deep at high water (9 or 11 feet at low water) by excavation, by rebuilding one of the existing piers, by adding wings to the other three, extending up and down stream and converting them into T walls, and by building ten new piers, extending down stream in curves. The piers were to be built of riprap 3 feet wide on top, with side slopes of 45°; they were to be built to heights of from 1½ to 3½ feet above highest tide, those farthest up stream being the highest. The piers were estimated to require 43,436 cubic yards of riprap, and the excavation was placed at 27,895 cubic yards for the 12-foot channel, or 69,251 cubic yards for the 14-foot channel, the cost of the whole work was estimated at $72,650.

The project was adopted, and under appropriations of 1836, 1837, and 1838, $40,000 in all, the piers were built nearly as designed with the exception of two of the new piers and one wing wall, which were not constructed; considerable dredging was done, but no complete record of amounts appear to have been kept.

Work was stopped in 1839 by exhaustion of appropriations.

In 1866 a petition of citizens of Norwich, asking for an appropriation for removing obstructions in the river Thames, was referred to the Chief of Engineers and returned by him to the Secretary of War with a report describing the work done upon the river, recommending no further work on the piers until their efficiency could be investigated satisfactorily, and stating: "In conclusion it is considered that should the sum of $8,000 be appropriated for the improvement of this river, to be applied during the next fiscal year, all will be accomplished that can be justifiably undertaken until a commission decides upon other efficacious methods or systems of improvement."

June 23, 1866, an appropriation of $10,000 was made for improving the river under which a survey was made, and a project for dredging

to obtain a depth of 11 feet at low water (14 feet at high water) was adopted.

Under this and succeeding appropriations up to 1878, this channel was dredged and as far as possible maintained with a width of 100 feet. March 3, 1879, $12,000 was appropriated "for the improvement of the Thames River to secure a 14-foot channel," and in accordance therewith the project was modified to provide for a channel of that depth at low water.

In 1882, upon recommendation of Major Barlow, approved by the Board of Engineers the project was further modified by providing for the construction of five dikes or training-walls along the outer sides of the channel curves, with the addition of low walls on the inner sides should they be found necessary, the width of the water-way between them increasing from 300 feet (about the full width of the river) at Thamesville, 1 mile below Norwich, to 480 feet at the lower dike.

The object of the training-walls was to utilize the action of the tides, to keep the channel open; they were to be built up to high-water level, and to have an aggregate length of 13,800 feet. In the same year the projected width of the channel was increased to 200 feet. The improvement was designed to extend over the first 3½ miles below Norwich, and the estimated cost was:

For the five dikes, or training walls	$82,800
For dredging 200 feet wide and 14 feet deep	125,280
Total	208,080

Under several appropriations up to 1888, work was carried on under this project without modification.

In May, 1888, in response to a letter from the Hon. Charles Russell, M. C., to the Secretary of War, asking the "approximate cost of completing the 16 feet deep channel to Allyn's Point, and the 14 feet deep channel to Norwich," estimates for the same were submitted as follows:

By act of Congress of August 11, 1888, an appropriation of $50,000 was made for continuing the improvement of Thames River, with a clause authorizing its expenditure "at any point between Norwich and New London." The project was, therefore, extended to include the above-described work, and as now adopted it consists in making and maintaining, by dredging and by a system of training-walls, a channel 200 feet wide from New London to Norwich, having 16 feet depth at low water up to Allyn's Point, about 5 miles below Norwich, and 14 feet from Allyn's Point to Norwich.

The additional cost of the extension of the project made in 1888, about $40,000, makes the present estimate for completion $95,600; the estimated cost of annual maintenance should also be increased to $8,000.

Under this project, up to July 1, 1889, 237,304 cubic yards of sand etc., had been dredged from the channel above Allyn's Point, and 84,890 cubic yards of sand and mud from the 16-foot channels at and below Allyn's Point; the three dikes farthest down-stream had been built and a fourth one to about three-quarters its contemplated length.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1890.

The contract for dredging to 14 feet depth above Allyn's Point, in progress at the beginning of the fiscal year, was completed October 24, 1889; the amount dredged since July 1, 1889, was 50,421 cubic yards. The sharp point of the bend at Long Reach was cut off, and the channel

at Walden's Island was made 175 feet wide and 14 feet deep. The total amount dredged under this contract was 83,968 cubic yards.

March 31, 1890, proposals were received for repairing the dikes in the river, by adding riprap and flat stones and by removing part of one of the old piers and placing the stones in line of the rolling mill-dike. Under date of April 23, 1890, a contract for this work was entered into with S. & E. S. Belden, of Rocky Hill, Conn., at the rates of 96 cents per ton for riprap, $1.13 per ton for flat stones, and 55 cents per cubic yard for removal of old pier. Work was begun June 10, and up to the close of the fiscal year 894 tons of flat stones and 247 tons of riprap had been delivered, nearly completing the repairs to the pile-dike at Mohegan; work is still in progress.

PRESENT CONDITION OF IMPROVEMENT.

Of the five dikes or training-walls provided for the project the four farthest down-stream have been built at cost as follows:

	Date of completion.	Length.	No. of tons of riprap, exclusive of repairs.	Cost, exclusive of supervision.
		Feet.		
Mohegan, 3¼ miles below Norwich	1883	2,988	(*)	$23,686.00
Trading Cove, 2¼ miles below Norwich	1882	2,370	17,207	21,113.05
Long Rock, 2 miles below Norwich	1885	2,800	11,945	12,781.15
Rolling-Mill, 1¼ miles below Norwich	1887	3,093	18,521	18,772.58

* Pile-dike.

The Rolling-Mill Dike, originally designed to be 4,350 feet long, is now 3,093 feet long, with a gap of 390 feet at the "sand pier," and extends northward nearly to the Lower Rolling-Mill embankment.

The project contemplated extending it about 600 feet north of the embankment, but since its adoption the Lower Rolling Mill Company has dredged a channel towards shore on the north side of their embankment, which is now used as a landing. It would be necessary to leave an opening for this channel, and probably it will be found expedient not to extend the dike above the embankment.

The upper dike one-half mile below Norwich, has not been begun.

The lower three dikes have settled from one-half foot to 1½ feet; they will be repaired under the existing contract.

The low-water depth in the channel from New London to Allyn's Point is not less than 16 feet, with width of 200 feet or over; from Allyn's Point to the upper end of the Walden's Island Reach, the depth is 14 feet and the width not less than 175 feet; above the latter point, up to Norwich, the depth is 11 feet or over, and the width from 75 to 150 feet.

PROPOSED OPERATIONS.

Under the contract in progress the dikes will be repaired.

Future appropriations will be applied to completing the dikes and to making and maintaining a channel 200 feet wide, to be 16 feet deep at mean low water up to Allyn's Point, and thence to Norwich to be 14 feet deep, as projected.

Appropriations for the improvement of Thames River have been made as follows:

Application.	Date.	Amount.
Removal of obstructions placed during the war of 1812	Mar. 3, 1821	$150
Survey	Mar. 2, 1829	150
Piers and dredging	July 4, 1836	10,000
Do	Mar. 3, 1837	20,000
Do	July 7, 1838	10,000
Dredging and survey	June 23, 1866	10,000
Dredging	Mar. 3, 1867	72,000
Do	Mar. 3, 1871	15,000
Do	June 10, 1872	10,000
Do	June 18, 1878	10,000
Do	Mar. 3, 1879	12,000
Do	June 14, 1880	22,500
Dredging and training-walls	Mar. 3, 1881	30,000
Training-walls	Aug. 2, 1882	*35,000
Do	July 5, 1884	*25,000
Training-walls and dredging	Aug. 5, 1888	*22,500
Repair of training-walls and dredging	Aug. 11, 1888	*50,000
Total		354,800

*Appropriated for present project: These with $20,000 from previous appropriation (see Annual Report for 1882, part 1, page 603) make total of $152,500 for present project.

The Thames River is in the collection district of New London. The nearest lighthouse is at the mouth of the river, on the west shore. Forts Trumbull and Griswold overlook the mouth of the river from either shore.

Money statement.

July 1, 1889, amount available		$20,121.12
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$2,683.48	
July 1, 1890, outstanding liabilities	1,247.34	
July 1, 1890, amount covered by uncompleted contracts made during fiscal year ending June 30, 1890	4,892.16	
		8,832.98
July 1, 1890, balance available		11,298.14
Amount appropriated by act of September 19, 1890		20,000.00
Amount available for fiscal year ending June 30, 1891		31,298.14
Amount (estimated) required for completion of existing project		75,600.00
Amount that can be profitably expended in fiscal year ending June 30, 1892		75,600.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for repairing dikes in Thames River, Connecticut, opened March 31, 1890, by Col. D. C. Houston, Corps of Engineers, U. S. Army.

Number.	Name and address of bidder.	Rate per ton for riprap (2,400 tons).	Rate per ton for flat stones (1,350 tons).	Rate per cubic yard for removing and depositing stone (4,200 cubic yards).	Amount of bid.	Remarks.
1	James Scully, Groton, Conn.	$1.15	$1.30	$1.20	$9,555.00	Character of stone not stated.
2	Humphrey Toomey, Guilford, Conn.	1.25	2.00	2.50	16,200.00	Informal certificate signed by notary public instead of United States official.
3	S. & E. S. Belden, Rocky Hill, Conn.	.96	1.13	.55	6,139.50	Riprap brown stone, gneiss, or granite.
4	Wm. H. Molthrop & Co., New London, Conn.	1.00	1.20	1.24	9,228.00	Granite from Ledyard, Conn.

NOTE.—*Amount available for work*, about $18,000.

Abstract of contracts for improving Thames River, Connecticut, in force during the fiscal year ending June 30, 1890.

Name and address of contractor.	Date of contract.	Subject of contract.	Prices.	Remarks.
Hartford Dredging Company, Hartford, Conn.	Feb. 4, 1889	Dredging	15.7 cents per cubic yard.	Contract completed Oct. 24, 1889.
S. & E. S. Belden, Rocky Hill, Conn.	Apr. 23, 1890	Repair of dikes	Riprap per ton, 96 cents; flat stones per ton, $1.13; removing and depositing stones, per cubic yard, 55 cents.	Contract in progress.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1889.

From the best obtainable data the amount of freight carried on this river above New London during 1889 was about 404,000 tons. By far the larger part of this is coal; the rest is iron, building materials, dye-woods and general merchandise.

It is carried in vessels drawing from 4½ to 16 feet of water.

The tonnage reported for 1888 was about 255,000 tons, showing an apparent increase in 1889 of 149,000 tons. It is not believed that the commerce of the river has increased to this extent; the difference is probably largely due to errors in the data, which are furnished by parties interested in commerce, and are the best that can be obtained.

Tonnage of Thames River, above New London, 404,000 tons. No statistics for New London are received, but the New London Harbor tonnage was estimated at about 700,000 tons additional in Annual Report of 1888.

D 2.

IMPROVEMENT OF NEW LONDON HARBOR, CONNECTICUT.

New London Harbor is that part of the Thames River which lies in front of the city of New London, extending from Winthrop's Point to Long Island Sound, a distance of about 3 miles. It has good anchorage ground and a channel from 30 to 50 feet deep and a quarter of a mile wide, extending up to Winthrop's Point. It is one of the best harbors on the Atlantic coast.

PROJECT FOR IMPROVEMENT.

In the Annual Report for 1878 upon the improvement of Thames River (see Annual Report of the Chief of Engineers for 1878, Part 1, page 397), shortly after the completion of the New London Northern Railroad Wharf, a petition of certain citizens of New London and Norwich was presented, asking that the United States undertake the removal of a shoal east of that wharf. The desired work was estimated to cost $6,800, and it was recommended that it be included in the general project for the improvement of the Thames River. The estimate was as follows:

To remove the shoal and bowlders to a depth of 16 feet at mean low water will require the excavation of 125 cubic yards of bowlders, at $5 per yard	$625
37,000 cubic yards of gravel and mud, at 15 cents per cubic yard	5,550
Add for contingencies	625
Total	6,800

This shoal extended from the shore out about as far as the end of the wharf. The part whose removal was contemplated was that part lying south of a line running east from a point on the railroad wharf 500 feet from its outer end.

The river and harbor act approved June 14, 1880, appropriated "for the improvement of the Thames River, of which sum $2,500 shall be expended in the removal of rocks and sand from New London Harbor, $25,000."

In 1881 and subsequently appropriations were made for improving New London Harbor.

The first work under this project, so inaugurated, was done in 1880. It was found that the presence of bowlders made the dredging much more expensive than had been counted on, and in the Annual Report for 1881 (see Annual Report of the Chief of Engineers for 1881, Part 1, page 586) a new estimate was submitted, placing the cost from the beginning at $24,000.

In 1882 the project was modified so that the area to be dredged should be that part of the shoal lying southwest of a line running about southeast from a point on the wharf 600 feet from its outer end; the object of this modification was to avoid as far as possible the large bowlders that were found near the crest of the shoal, and to keep the cost of the work within the last estimate, while affording no less accommodation to vessels using the wharf. The depth over this part of the shoal was from 5 to 15 feet at mean low water.

Nineteen thousand eight hundred dollars have been appropriated for this work; 22,902 cubic yards of sand and stones and 564 cubic yards of bowlders have been removed.

The proportion of bowlders to mud and gravel in the original estimate was about 1 to 300; the proportion actually found has been about 1 to 41. The actual cost of dredging mud and gravel has averaged 54 cents per cubic yard. The bowlders have ranged in size from one-fourth cubic yard to 5 cubic yards, many of them having to be blasted.

Under provision of the river and harbor act of 1888, a preliminary examination of the harbor was made, the report on which, printed in the Annual Report of the Chief of Engineers for 1889, Part I, page 744, presented a plan and estimates for the new improvement desired, viz, deepening the approaches to the city water-front.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1890.

No work was done, the project being substantially completed.

Appropriations for improving New London Harbor have been made as follows, viz:

Application.	Date.	Amount.
Dredging shoal east of railroad wharf	June 14, 1880	*$2,500
Do	Mar. 3, 1881	4,300
Do	Aug. 2, 1882	9,000
Do	July 5 1884	2,000
Do	Aug. 5, 1886	2,000
Total		19,800

* Part of appropriation for Thames River improvement.

New London, the port of entry for the collection district of New London, is situated on the west bank of the Thames River, about 2½ miles from Long Island Sound. The harbor is the mouth of the Thames River.

New London light-house is located at the entrance to the harbor, on the west shore. Forts Trumbull and Griswold command the harbor from either side.

Money Statement.

July 1, 1889, amount available	$201.39
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	201.39

D 3.

IMPROVEMENT OF THE CONNECTICUT RIVER, MASSACHUSETTS AND CONNECTICUT.

This river rises in the northern part of New Hampshire, flows in a general southerly course between the States of New Hampshire and Vermont, crosses the States of Massachusetts and Connecticut, and empties into Long Island Sound at Saybrook Point, Conn. It is divided naturally into two parts, Hartford, Conn., at the head of navigation being the point of division, and appropriations by Congress have generally specified inwhich part the money appropriated was to be expended.

The divisions are as follows:

1. *Above Hartford, Connecticut.*—Embracing a length of about 66 miles, from Hartford, Conn., to Miller's Falls, Mass.

2. *Below Hartford, Connecticut.*—Embracing a length of about 50 miles, from Hartford to Long Island Sound.

By the river and harbor act of 1882 an examination or survey of the Connecticut River from Bellows Falls, Vt., to Pittsburgh, N. H., was authorized. Bellows Falls is about 105 miles above Hartford, and Pittsburgh is 180 miles above Bellows Falls. A preliminary examination was made, the report on which, printed in the Annual Report of the Chief of Engineers for 1884, Part I, page 659, recommended no survey and proposed no plan of improvement.

(1) ABOVE HARTFORD, CONNECTICUT.

Miller's Falls, Mass., is at the head of possible navigation of the Connecticut River. From this point down to Holyoke, Mass., a distance of about 32 miles, the river is susceptible of improvement, but it can not be used by vessels now on account of a dam and falls at Holyoke which entirely obstruct navigation. The lockage required to lift boats from the lower to the upper levels at Holyoke is about 60 feet. From Holyoke, Mass., to Enfield Falls, Conn., a distance of 18 miles, there is a fair channel 4 to 5 feet deep at low water, which could be made 8 feet deep. Enfield Falls, or Rapids, cover a stretch of river about 5 miles long, having a fall of about 32 feet at low water. The bed is rocky and very uneven, and the slope is not uniform, but consists of a succession of long, shallow reaches separated by rapids.

From the foot of Enfield Falls to Hartford, a distance of 11 miles, the river has a broad, sandy bed with a depth of 2 to 5 feet at low water. Under a charter from the State of Connecticut, granted in May, 1824, the Connecticut River Company has constructed a canal, with locks, around Enfield Falls. The locks are 80 feet long, 18 feet wide, and 4½ feet deep. The canal is chiefly used for water-power; the company collects toll from vessels using it.

Following is a list of places in this part of the river where work has been done by the United States, with distances above the wagon bridge at Hartford:

	Miles.
Barber's Landing	4
Farmington River	5
Strong's Island	6¼
Scantic River	7¼

PROJECTS FOR IMPROVEMENT.

No general project for the improvement of this part of the river is on record as approved and adopted. All the work done has been under

special projects for expenditure of the several appropriations. It consists of dredging at Barber's Landing in 1873, and construction of dikes, or wing-dams, at Scantic River, Strong's Island, and Farmington River in 1871, at Farmington River and Barber's Landing in 1878, and again in 1880 and 1881.

Plans and estimates for a larger canal around Enfield Falls were submitted in 1878 and modified in 1880. (See Annual Report of the Chief of Engineers for 1881, Part I, page 566.) They proposed a canal on the east bank of the river, extending from above Enfield Falls down to the mouth of the Hockanum River, opposite and just below Hartford, as the best means of gaining an available depth of 8 feet from Hartford to and around the falls.

The canal levels were to be 10 feet deep at low water and 120 feet wide at the water-line; the locks 200 feet long, 55 feet wide, with 8 feet depth over the miter-sills at low water. The cost of the work was estimated at $1,332,805. It was considered not advisable to begin construction with a less sum than $450,000.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1890.

No work was done. The available money is insufficient to begin any general plan of improvement in this part of the river.

PRESENT CONDITION OF IMPROVEMENT.

The wing-dams are all in fair condition; they are as follows:

One at Scantic River, one at Strong's Island, one at the mouth of Farmington River, two nearly opposite the mouth of Farmington River, and two on the east bank, opposite Barber's Landing.

The available channel depth from Hartford to Scantic River is about 2 feet at ordinary summer stage of water; this part of the river is navigable for freighting only when in freshet. No work has been done above Scantic River; the depth from there up to the foot of Enfield Falls is greater than from there down to Hartford.

PROPOSED OPERATIONS.

No work in the river above Hartford is contemplated during the ensuing year. Should any injury to the wing-dams occur, the money available will be sufficient for repairs.

Appropriations for improving the Connecticut River above Hartford have been made as follows:

Application.	Date.	Amount.
Dams at Scantic River, Strong's Island, Farmington River, and Barber's Landing; repairs of dams; dredging at Barber's Landing; surveys.....	July 11, 1870	$20,000
	Mar. 3, 1871	20,000
	June 10, 1872	25,000
	Mar. 3, 1873	20,000
	June 14, 1880	15,000
Total.....	.....	100,000

Of these amounts the following balance is yet unexpended:

From the appropriation of June 14, 1880, for "improving Connecticut River between Hartford and Holyoke," $8,940.30.

Money statement.

July 1, 1889, amount available	$9,133.20
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	192.90
July 1, 1890, balance available	8,940.30

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1889.

Receipts by water.

Articles.	Tons.	Value.
Coal	1,800	$10,000
Paper and paper stock	300	300
Total	2,100	10,300

Vessels employed in this traffic.	Tonnage.	Draught.
	Tons.	*Feet.*
2 steam-tugs	30	4
4 scows	30	4

In its present condition this part of the river is navigable only during freshets. The Enfield Canal was closed at Windsor Locks for repairs during the greater part of the year 1889.

(2) BELOW HARTFORD, CONNECTICUT.

The Connecticut River below Hartford is a large stream, for the first 21 miles flowing in a winding course, mostly through alluvial meadows, which are overflowed at high water, and which consist of a light, sandy soil, easily undermined. For the remaining 29 miles to Long Island Sound, at Saybrook Point, the course is straighter, the banks more permanent and generally harder.

A gauge has been established at Hartford, whose zero is the lowest stage that the water is known to have reached from natural causes; closing the gates at the Holyoke Dam in time of drought has caused the water to fall lower. The usual low-water stage of the river in the summer is about 1 foot on this gauge; spring freshets ordinarily rise to 20 feet; the highest recorded stage of water is 29 feet.

The average tide at Saybrook is 3½ feet; at Hartford it is about 1 foot, though when the water stands above 5 feet on the Hartford gauge the tide there is not perceptible. The slope of the river from Hartford to Saybrook averages .0458 foot per mile. The bed of the river, through the alluvial meadows within 10 miles of Hartford, is constantly changing from the undermining of the banks. It is said that in places it has changed its position a half mile. The bars in this part of the river, after being dredged, form again during freshets and ice-jams, so that some of them require dredging annually; others less frequently. This part of the river was worked upon by corporations and private parties at various times between 1800 and 1870. Several small stone piers, to deepen the channel at shoal places, were built in this way. Some of these are covered by new banks, the channel has shifted to the opposite side of others, and others still have been dredged out because they had come to be obstructions. The depth sought by these works was 3 feet at low water.

The following list gives the names of the several places on the river below Hartford where work has been done by the United States, with their distances by course of channel below the Hartford wagon bridge:

Locality.	Miles.	Locality.	Miles.
Hartford Bar	1½	Mouse Island Bar	20½
Clay Banks Bar	2½	Haddam Island Bar	30
Pratt's Ferry or Naubuc Bar	5½	Chester Rock	38
Press Barn Bar	6¾	Brockway's Bar	41
Glastonbury Bar	9½	Calves Island Bar	44½
Dividend Bar	12	Saybrook Bar (at mouth)	50
Pistol Point Bar	15		

PROJECTS FOR IMPROVEMENT.

By act of July 4, 1836, Congress appropriated $20,000 "for improveing the harbor at Saybrook, by removing the bar at the mouth of the Connecticut River." Under this appropriation a survey was made by Capt. W. H. Swift, United States Engineer Corps. In his report on this survey, dated January 31, 1837, and printed in House Ex. Doc. No. 252, Twenty-fifth Congress, Captain Swift submitted a project for deepening the west channel over Saybrook Bar, dredging a cut 500 feet wide and 12 feet deep at mean low water, at an estimated cost of $54,380.50; the estimated cost per cubic yard for dredging and dumping was 25 cents. The available depth over the bar before dredging was 7 feet at mean low water. Captain Swift's project was approved, and work was begun in May, 1838, under contract with Randall, Haskell & Holmes, at the rate of 62½ cents per cubic yard, measured in scows; dredging was continued until the fall of 1840, when the appropriation was exhausted; 26,984 cubic yards of sand and stones had been removed, making a channel 1,500 feet long, 50 feet wide, and from 11 to 12 feet deep. This channel was nearly destroyed by storms and freshets in the following winter and spring. March 1, 1843, $3,471.57 was appropriated to pay a balance due the contractors.

No further work was done upon the river until 1867. By act of Congress, approved March 2, 1867, a survey of the river was ordered, which was made in the following season, and which embraced all the principal bars and obstructions between Hartford and Long Island Sound. With the report on this survey, dated January 11, 1868, and printed on page 754 *et seq.*, of the Annual Report of the Chief of Engineers for 1868, was presented a project for improving this part of the river; it proposed dredging at Hartford, Clay Banks, Pratt's Ferry, Glastonbury, and Pistol Point, to make channels 8 feet deep at low water and 100 feet wide, dredging at Saybrook Bar to make a channel 8½ feet deep and 200 feet wide, piling for shore protection at Hartford and Wethersfield, and the removal of Chester Rock, at a total estimated cost of $70,000; an estimate of $10,000 for annual maintenance was submitted. All the dredging done up to 1880 was in accordance with this project, extended to make 9 to 9½ feet depth, instead of 8 feet, and also to include Press Barn, Dividend, and Mouse Island bars; the piling at Hartford was built in 1871, and the removal of Chester Rock was begun in the same year, but abandoned by the contractor soon after beginning.

January 22, 1873, a project for building three jetties at Saybrook and for dredging was approved by the Secretary of War; the jetties were to be of a double row of piles 20 feet apart, filled with stone to a height of 8 feet above low water; the dredging was to be 9 feet deep and 400 feet wide.

The estimated cost was:

Dredging	$17,850
Jetties	318,760
Total	336,610

Before work on the jetties was begun the plan of construction was modified to one for building them of riprap stone, triangular cross-section, rising to level of highest water, *i. e.*, about 5 feet above mean low water, this plan being much more economical than the previous one.

The jetties were begun in 1873, and two of them were completed in 1881. The third has not been built, and may not be needed; the west jetty has since been extended, and both have been repaired and strengthened.

In 1880 a project was adopted for permanent works of improvement at six of the worst bars (see Annual Report of the Chief of Engineers for 1880, Part 1, page 396 *et seq.*).

This project provided for riprap wing-dams, mattress, shore protection, and rectification of the banks at the following places, viz:

Locality.	Amount.	Locality.	Amount.
Hartford Bar	$33,464	Glastonbury Bar	$114,922
Clay Banks Bar	69,116	Dividend Bar	7,119
Pratt's Ferry or Nanbuc Bar	64,735		
Press Barn Bar	41,140	Total	390,487

With dredging, to make and maintain a permanent channel. The project did not provide for extension and repair of the Saybrook jetties, nor did the estimate include any amount for annual dredging to maintain channels, nor for dredging between the jetties at Saybrook, nor for any work whatever at Pistol Point, Mouse Island, Haddam Island, and Calves Island bars, where dredging has since been required; all of these have consumed a large part of the appropriations made since.

Under this project, extended as above, up to the close of the last fiscal year, a training-wall of riprap, 3,689 feet long, had been built at Hartford Bar (instead of the proposed wing-dam), and a riprap wing-dam 5,300 feet long had been built at Glastonbury Bar, both to the height of 3 feet above low water; part of the Hartford training-wall was subsequently built to 4 feet above low water; the west jetty at Saybrook had been extended to the 16-foot curve, the east jetty to the 12-foot curve, and a channel 130 feet wide and 12 feet deep had been dredged between them, besides maintaining the required depth in this part of the river by annual dredging, at a cost of from $5,000 to $10,000 each year.

In 1887 it had become evident that the proposed plan of permanent improvement would not materially reduce the amount of dredging annually required, and that no effectual substitute could be recommended which would not be very expensive; and in December, 1887, a new project was adopted, under which future operations were to be confined to completing the jetties at the mouth of the river to a height of 5 feet above high water, with a top width of 6 feet, widening the channel between the jetties to 400 feet with a depth of 12 feet at mean low water, and annual dredging to maintain the channel from Hartford to Long Island Sound, at an estimated cost as follows:

For completing jetties	$60,000.00
For dredging between jetties	20,000.00
	80,000.00

For average annual maintenance of channel from Hartford to Long Island Sound, $10,000.

The reasons for this change of project are fully given in a letter printed in the annual report of the Chief of Engineers for 1888, Part 1, pages 536–538.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1890.

At the close of the last fiscal year dredging was in progress under a contract for hire of dredging plant at the rate of $8.45 per actual working hour; the plant had worked 372¼ hours, removing 22,233 cubic yards of material.

Work under this contract was continued until September 30, the amount of material dredged since July 1 being 41,211 cubic yards, and the actual working time being 719⅝ hours.

Following is a statement of the amount of material dredged from the several bars during the calendar year of 1889:

	Cubic yards.		Cubic yards
Hartford Bar	34,622	Dividend Bar	5,753
Clay Banks	4,435	Brockway's Bar	4,668
Press Barn	3,039		
Glastonbury	10,927	Total	63,444

A navigable channel of 9 feet depth at low water was made and maintained from Hartford to Long Island Sound, with width of 50 to 100 feet.

At the beginning of the season of 1890 the available balance for annual dredging was about $500; authority was granted by the Chief of Engineers to expend this sum in dredging as an open-market transaction at the rate of 12 cents per cubic yard. Under this authority work was begun May 5, 1890, and during the month of May 4,166 cubic yards of sand were dredged from Glastonbury Bar, making a channel 9 feet deep at low water and about 40 feet wide, and practically exhausting the available balance of appropriation.

It is understood that dredging has been continued by private parties at Glastonbury, Dividend, and Hartford Bars.

PRESENT CONDITION OF IMPROVEMENT.

A depth of 9 feet at low water exists through Glastonbury Bar, made with the available balance of the appropriation of August 11, 1888. The other bars have depths of from 6 to 8 feet, as left by the spring freshets, except where they have been deepened by private work.

The channel between the Saybrook jetties, dredged 12 feet deep and 130 feet wide, retains nearly that depth and width.

The Hartford Dike is in good condition; the Glastonbury Dike, built on a convex bank, is now nearly covered by the advance of the bank.

Both jetties at Saybrook are in fair condition. They should be built up to the dimensions provided for in the project to make them permanent.

The length of the dikes and jetties is as follows:

	Feet.
Hartford Dike	3,698
Glastonbury Dike	5,300
Saybrook:	
West Jetty	2,550
East Jetty	2,316

PROPOSED OPERATIONS.

The object of first importance will always be the annual maintenance of the 9-foot channel from Hartford to Long Island Sound.

An estimate of $50,000 is submitted for raising the dike at Hartford. The reasons for this are given in my letter to the Chief of Engineers, dated October 19 and October 24, 1889, copies of which accompany this report. This will involve an increase in the estimate for completion from $80,000 to $130,000, but it is believed that the effect of raising the dike will be to considerably reduce the cost of annual maintenance by dredging, now estimated at $10,000, and cause less interference with navigation by the occupation of the low-water channel by the dredging plant. Moreover, the revised estimate of $80,000, submitted for the completion in 1888, was a reduction in the estimate of works previously proposed of about $292,000.

In 1879 a project was submitted for certain permanent improvements at an estimated cost of $330,487; under this project $38,392.80 has been expended. The present estimates do not contemplate any further work under this project.

The estimates for completion now submitted are:

For completing jetties at mouth of river	$60,000
Dredging channel between them	20,000
Raising dike at Hartford	50,000
Total	130,000

Annual maintenance of channel from Hartford to Long Island Sound, $10,000.

Appropriations for improvement of the Connecticut River below Hartford have been made as follows:

Application.	Date.	Amount.
Dredging at Saybrook Bar	July 4, 1836	$20,000.00
Dredging at Saybrook Bar (the unexpected balance of 1836 was re-appropriated	Mar. 3, 1839	.....
Balance due contractors under previous appropriations	Mar. 1, 1843	3,471.57
Survey	Mar. 2, 1867	3,995.22
Dredging at Pratt's Ferry, Pistol Point, Mouse Island; piling at Hartford	July 11, 1870	20,000.00
Dredging at Hartford, Clay Banks, Pier I, Pier J, Pratt's Ferry, Glastonbury, Pistol Point, and Chester Rock	Mar. 3, 1871	35,000.00
Dredging at Pratt's Ferry, Pistol Point, Saybrook Jetty	June 10, 1872	40,000.00
Dredging at Hartford, Pratt's Ferry Glastonbury, Saybrook Jetty	Mar. 3, 1873	20,000.00
Dredging at Hartford, Pratt's Ferry, Saybrook, Saybrook Jetties	June 23, 1874	20,000.00
Dredging at Hartford, Pratt's Ferry, Glastonbury, Saybrook Jetties	Mar. 3, 1875	20,000.00
Dredging at Hartford, Pratt's Ferry, Glastonbury, Saybrook Jetties; Salmon River dredging	Aug. 14, 1876	20,000.00
Compensation for previous dredging	1878	4,203.00
Saybrook Jetties; survey from Hartford to Rocky Hill	June 18, 1878	30,000.00
Dredging at Hartford, Press Barn, Glastonbury	Mar. 3, 1879	10,000.00
Dredging at Hartford, Glastonbury, Saybrook Jetties	June 14, 1880	10,000.00
Dredging at Hartford, Pratt's Ferry, Glastonbury, Glastonbury wing-dam, Saybrook Jetties	Mar. 3, 1881	30,000.00
Dredging at Hartford, Clay Banks, Pratt's Ferry, Press Barn, Glastonbury, Dividend, Pistol Point, and Salmon River, Hartford Dike	Aug. 2, 1882	45,000.00
Dredging at Hartford, Clay Banks, Pratt's Ferry, Press Barn, Glastonbury, Dividend, Pistol Point, Mouse Island, and between Saybrook Jetties; extending west jetty at Saybrook	July 5, 1884	35,000.00
Dredging at Hartford, Clay Banks, Naubac, Press Barn, Glastonbury, Dividend, Pistol Point, and Haddam Island; repair of Hartford Dike and Saybrook Jetties	Aug. 5, 1886	26,250.00
Compensation for previous dredging	Mar. 3, 1885	4,745.43
Annual dredging at Hartford, Clay Banks, Press Barn, Glastonbury, Dividend, Brockways	Aug. 11, 1888	10,000.00
Total	.....	407,665.22

The Connecticut River is in the collection district of Hartford. By course of river *the distance* from Holyoke, Mass., to Hartford, Conn., is about 34 miles, and from

Hartford to Long Island Sound about 50 miles. There is a light-house on Saybrook Point, on the west shore of the river, at its mouth, and another at the end of the west jetty, besides which there are three small beacon-lights in the lower part of the river which are maintained by the United States.

Fort Trumbull, New London Harbor, Connecticut, about 16 miles east from Saybrook Point, is the nearest work of defense.

Money statement.

July 1, 1889, amount available		$4,255.68
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$3,739.26	
July 1, 1890, outstanding liabilities	499.92	
		4,239.18
July 1, 1890, balance available		16.50
Amount appropriated by act of September 19, 1890		12,500.00
Amount available for fiscal year ending June 30, 1891		12,516.50
Amount (estimated) required for completion of existing project		117,500.00
Amount (estimated) required for annual maintenance of channel		10,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892		90,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of contract for improving Connecticut River, in force during the fiscal year ending June 30, 1890.

Name and address of contractor.	Date of contract.	Subject.	Price per hour.	Remarks.
J. H. Fenner, Jersey City, N. J.	Apr. 23, 1889	Hire of dredging plant.	$8.45	Contract completed Sept. 30, 1889.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1889.

Receipts and shipments by water.

	Tons.	Value.
Coal	310,000	$1,400,000
Stone	420,000	2,000,000
Miscellaneous	340,000	50,000,000
Total	1,070,000	53,400,000

The total tonnage reported for the calendar year 1888 was 1,050,000, the increase in 1889 being 20,000 tons.

Vessels employed in above traffic.

[Draught 7 to 12 feet.]

Description.	Number.	Tonnage.
Owned in district:		
Steamers	17	3,550
Sail-vessels	50	5,400
Barges	23	4,800
Not owned in district:		
Vessels of all kinds	90	14,088
Total	180	27,838

No new lines of transportation have been established on this river since the last annual report.

LETTERS RELATING TO THE PROPOSED RAISING OF DIKE AT HARTFORD.

ENGINEER OFFICE, U. S. ARMY,
New York, October 19, 1889.

GENERAL: In my letter of December 21, 1887, on the improvement of the Connecticut River (Annual Report of the Chief of Engineers for 1888, page 536) I recommended that the work in future above the mouth of the river be confined to periodical dredging. The experience of the last three years suggests a modification of this recommendation so far as relates to the dike at Hartford.

The following is a record of the dredging done during the years 1887, 1888, and 1889 on the stretch of the river below Hartford where navigation is interfered with by the annual formation of bars:

	1887.	1888.	1889.
	Cu. yds.	*Cu. yds.*	*Cu. yds.*
Bar at Hartford	32,104	24,355	34,622
Bar at Clay Banks	5,700	8,714	4,435
Bar at Naubuc	3,461	.....	.....
Bar at Press Barn	2,449	.....	3,039
Bar at Press Barn and Crow Point	.....	6,934	.....
Bar at Glastonbury	5,079	8,969	10,927
Bar at Dividend	4,405	7,306	5,753
Bar at Pistol Point	4,717	6,339	.....
Total	57,915	62,617	58,776
Total for Hartford Bar	.....	.....	91,081
Total for other bars	.....	.....	88,227

It appears that the annual amount of dredging at Hartford Bar is more than at all the other bars. I transmit a tracing* showing the dike at Hartford which seems to be well located, and if built to the proper height, ought to maintain the required depth with a much smaller amount of dredging. The dike is 3,698 feet in length and has a height of about 5 feet above low water. Freshets attain an extreme height of 30 feet above low water.

For illustration, I inclose a tracing* giving the variations in water-level from 1872 to 1881.

It seems that the current in high stages flows over the dike and impinging against the bank returns to the channel creating cross-currents which interfere with the maintenance of the channel. If the dike were raised, an increased discharge would be confined to the channel for a greater length of time. The precise height to which the dike should be raised can only be determined by experience, but it is probable that it would not be necessary to raise it to more than 10 feet above low water, as the average yearly duration of higher stages is only about fifty-two days. The cost of raising the dike to this height is estimated to be $25,000. To raise it to 15 feet above low water would cost about $50,000; to 20 feet, about $80,000. In the most extreme case the estimate for completion would be very much less than the estimate submitted prior to 1888. The dike at Hartford has cost already $27,000, but with its present height does not seem to accomplish the purpose for which it was designed. It has, however, given a better direction to the channel than previously existed, and has prevented the erosion of the bank in front of the city.

* Omitted here.

It is therefore recommended that provision be made, in the estimates, for raising this dike to the proper height, as may be found necessary by experience, not to exceed $50,000 in addition to the estimate for completion submitted in the Annual Report for 1889, in order that a portion of the next appropriation, which should not be less than $30,000, may be applied to the dike.

Very respectfully, your obedient servant,

D. C. HOUSTON,
Colonel of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

ENGINEER OFFICE, U. S. ARMY,
New York, October 24, 1889.

GENERAL: I have the honor to acknowledge the receipt of your letter of the 22d instant, in reply to my letter of the 19th instant, recommending the raising of the dike in the Connecticut River at Hartford.

At the date of my annual report for 1889 there had not been sufficient dredging on the bars in the Connecticut River during the present season to justify the recommendation as to raising the Hartford Dike, which was based upon the results of this season's work in connection with that of former years, and upon the request of parties interested to have the dike raised or other steps taken to obviate the necessity of such a large amount of dredging, which interfered with navigation. The character of the work in the river is such that it is necessary to move the dredge from bar to bar, as the necessities of navigation demand.

During the present season this required dredging on the Hartford Bar at five different periods, viz:

	Cubic yards.
From May 20 to June 1	7,910
From June 11 to June 20	6,076
From July 17 to July 30	6,591
From August 12 to August 29	7,401
From September 17 to September 30	6,644
Total	34,622

This occasions considerable interference with navigation, which would be diminished if the dike were raised, with ultimate economy by a saving in periodical dredging. It is therefore desirable that, if possible, the next appropriation should be availible for raising the dike, and be sufficient to raise it to at least 5 feet above its present height. If this can not be done it is proposed, with your approval, to increase the estimates for completion in the next annual report.

Very respectfully, your obedient servant,

D. C. HOUSTON,
Colonel of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

D 4.

IMPROVEMENT OF CLINTON HARBOR, CONNECTICUT.

Clinton Harbor is on the north shore of Long Island Sound, about 10 miles west of the mouth of the Connecticut River. It consists of an open, shallow bay, and of the mouth of the Hammonasset River, a small stream which flows easterly in front of the town wharves and empties into the bay. For three-quarters of a mile above its mouth the river is separated from the bay by a narrow strip of sand and marsh. About 1840, a breach was made through this strip half a mile above the mouth of the river which diverted a considerable part of the tidal flow, and since then two shoals have formed, one just inside the river's mouth with 4.5 feet of water, and one out in the bay shortly before reaching deep water in the Sound, with a depth of 4 feet. It is said that formerly there were depths of from 8 to 12 feet on both these bars, and that shoaling occurred soon after the breach was made.

PROJECT FOR IMPROVEMENT.

By act approved March 3, 1881, Congress authorized a survey of the harbor, which was made the same year. In his report on the survey, dated January 17, 1882, and printed in the Annual Report of the Chief of Engineers for 1882, Part 1, page 630, Colonel Barlow, Corps of Engineers, submitted a project for restoring the original condition of the channel by closing the breach and by subsequently, should the increased tidal current not produce the deepening desired, dredging through the shoals, making a channel 100 feet wide and 6 feet deep at mean low water.

The cost of a dike to close the breach was estimated at $3,000, and the cost of the whole project, including the dredging, at $10,000.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1890.

Nothing was done. The available funds were not sufficient for continuing the improvement.

PRESENT CONDITION OF IMPROVEMENT.

The dike was built in 1883, using 1,574 tons of riprap granite, and costing, exclusive of superintendence, $2,219.34. An examination made in 1885 showed that it had settled about 2 feet, and would require about 500 tons of stone to build it up to full height; also that no material change in the channel had taken place since the dike was built. It seems established that the increase of tidal flow will not, of itself, deepen the channel as desired.

PROPOSED OPERATION.

It is proposed to complete the project by dredging channels 100 feet wide and 6 feet deep at mean low water through the two shoals in the harbor when the estimated funds, $7,000, are appropriated.

The only appropriation made for the improvement of this harbor is the one of $3,000 in 1882, expended in construction of dike.

Clinton harbor is in the collection district of Hartford. The nearest light-house is on Falkner's Island, 8 miles southwest. Fort Hale, New Haven Harbor, 22 miles west, is the nearest work of defense.

Money statement.

July 1, 1889, amount available	$252.73
July 1, 1890, balance available	252.73
Amount appropriated by act of September 19, 1890	3,500.00
Amount available for fiscal year ending June 30, 1891	3,752.73
Amount (estimated) required for completion of existing project	3,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	3,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1889.

Arrivals and departures of vessels		90 to 100
Shipments:		
Wood and lumber	tons	2,500
Hay and straw	do	300
Total		2,800
Receipts:		
Coal	tons	1,250
Lumber	M. feet	100
Oysters	bushels	8,000
Draught of vessels using the harbor	feet	4½ to 7
Tonnage of vessels using the barbor	tons	30 to 150

The above figures show an increased tonnage of freights over those reported for last year of about 300 tons.

No new lines of transportation have been established since the last annual report.

D 5.

IMPROVEMENT OF NEW HAVEN HARBOR, CONNECTICUT.

New Haven Harbor is a bay on the north shore of Long Island Sound, extending about 4 miles inland and from 1 to 2 miles wide. The Mill and Quinnipiac rivers empty into the head of the harbor; they are streams of no commercial importance, except for tidal navigation at and near their mouths.

The harbor channel is from 400 feet to a mile wide, with mud and sand flats on either side. When the Government began work in this harbor, in 1867, the available low-water depth from the city wharves to Crane's Bar, about one-third way down the harbor, was 9 feet; thence to Fort Hale, which is about half-way down, it was 16 feet or over; a short distance below Fort Hale was a bar of very soft mud extending across the harbor, with 13 feet available depth at mean low water.

The entrance to the harbor was partly obstructed by several sunken rocks.

PROJECTS FOR IMPROVEMENT.

Several plans for removal of certain of the rocks at the harbor entrance have been proposed and undertaken, but not completed. The removal of the harbor light-house to Southwest Ledge and the com-

pletion of the proposed system of breakwaters will obviate the necessity for further work upon these rocks.

The work of deepening the channel in this harbor has, for the most part, been done in accordance with plans presented in annual or special reports to the Chief of Engineers, the projects being adopted under subsequent appropriations, and not based upon examinations or surveys ordered by Congress.

In a letter dated January 20, 1871, printed as House Ex. Doc. No. 95, Forty-first Congress, third session, and also on page 771 of the Annual Report of the Chief of Engineers for 1871, General Warren, U. S. Engineers, states that "the business of New Haven requires that there should be a channel dredged 200 feet wide and to a depth of 14 feet at mean low water up to the wharves," and that this is "in many respects more important to New Haven than the removal of the rocks at the entrance to the harbor." It was estimated to cost $64,815. March 3, 1871, $40,000 was appropriated for this harbor, and it was expended in the same year in making a channel 13 feet deep, 200 feet wide up to Long Wharf, 350 feet wide at the bend at Long Wharf, and 100 feet wide from there to the steam-boat wharf.

In a letter of December 23, 1871, printed in House Ex. Doc. No. 137, Forty-second Congress, first session, General Warren submitted an estimate of $26,250 for dredging 16 feet deep and 200 feet wide across Fort Hale Bar, adding that there was some doubt as to the permanence of such a channel. June 10, 1872, $15,000 was appropriated for the removal of rocks and $20,000 for harbor improvement. The former amount was expended upon Luddington Rock; the latter, with part of an appropriation of $25,000 made March 3, 1873, was expended in dredging on Fort Hale Bar, and at the close of the season of 1873 the channel had been made 16 feet deep and 200 feet wide, as proposed. It soon filled to nearly its former condition. The 13-foot channel above Long Wharf was widened to 110 feet in the same year.

In the annual report for 1873 General Warren says "it is thought that no improvement here, beyond what can be accomplished with the funds now available, is called for on the part of the United States, and no further appropriation is asked for."

No appropriation for this harbor was made in 1874, and none was recommended in the Annual Report for that year.

January 21, 1875, the House of Representatives, by resolution, asked "for a report from surveys already made, in regard to the expediency of widening and deepening the main channel of New Haven Harbor, Connecticut, to a depth not exceeding 20 feet, and also the expediency and estimate of cost of a breakwater." In a report dated January 27, 1875, Colonel Barlow, U. S. Engineers, then in charge, submitted the following estimates, in reply to that part of the resolution relating to the channel (see Annual Report of the Chief of Engineers for 1875, Part II, page 250):

For channel 400 feet wide and 20 feet deep	$416,490
For channel 400 feet wide and 18 feet deep	276,990
For channel 300 feet wide and 20 feet deep	329,925
For channel 300 feet wide and 18 feet deep	208,890

Also, February 8, 1875, in reply to request from the Chief of Engineers, he estimated $10,000 as the cost of widening to 200 feet the 13-foot channel above Long Wharf, already 110 feet wide. In submitting these reports the Chief of Engineers recommended the latter work "as being of immediate importance, and whatever action may be taken upon the project of making a 20-foot channel, this at least should be

done." In a subsequent report on the same matter, February 9, 1875, Colonel Barlow presented an estimate of $35,000 for widening the channel above Long Wharf to 400 feet; this was transmitted to the House of Representatives by the Secretary of War February 13, 1875, with favorable indorsement of the Chief of Engineers. The latter plan was carried out under the appropriation of $10,000 made March 3, 1875, with a balance of about $6,000 from previous appropriations, and the 13-foot channel was made 415 feet wide above Long Wharf, the price of work being much lower than had been estimated.

Nothing was appropriated for this harbor in 1876 or 1877.

In the Annual Report for 1877 Colonel Barlow refers to the estimates submitted in his letter of January 25, 1875, and recommends that the channel below Long Wharf be made 400 feet wide and 16 feet deep, its then dimensions (200 feet wide and 13 feet deep) not affording "sufficient space for convenient navigation." The estimated cost was $40,000.

In 1878, under an appropriation of $25,000 made June 14, 1878, the channel was dredged to the length and depth proposed, with width of 300 feet.

In a letter of February 4, 1879, transmitting map of harbor examination made in December, 1878 (letter printed in the Annual Report of the Chief of Engineers for 1879, Part I, page 336), Colonel Barlow recommends deepening the channel above Long Wharf and widening the channel below to secure 400 feet width, with 16 feet depth from the steam-boat wharf down to Fort Hale; also dredging a channel 500 feet wide and 16 feet deep through Fort Hale Bar. The work above Fort Hale was estimated to cost $65,000; that below, $35,000. The proposed depth and slightly greater width above Fort Hale were obtained by October, 1881, under three successive appropriations of $15,000 each, made in 1879, 1880, and 1881. Nothing had been done on Fort Hale Bar.

In the Annual Report for 1879 a dike at Sandy Point (opposite Fort Hale) was suggested as a means of increasing the depth on Fort Hale Bar, but on account of its expensiveness was not recommended to be undertaken until dredging had been tried again.

In the Annual Report for 1880 (Part I, page 445) Colonel Barlow renews his recommendation for dredging a channel through Fort Hale Bar 500 feet wide and 16 feet deep.

In the annual report for 1881 (Part I, page 592), after current observations and borings had been made, a dike from Sandy Point is recommended, the length to be determined experimentally as construction progresses, but to be at least 4,400 feet, which length was estimated to cost $60,000.

Under appropriation of $30,000 made August 2, 1882, a plan for this dike was submitted and referred to the Board of Engineers, by whom it was slightly modified and approved October 2, 1882.

The project as approved consisted of a dike connected with Sandy Point by a shore-arm about 2,160 feet long, and extending southward as a channel-arm about 3,[illegible]00 feet, the channel-arm and part of the shore-arm to be built of creosoted piling in double rows filled in with stone. In 1883 the location of the shore-arm was modified upon the request of oyster-growers in the vicinity, and in 1886 the method of construction was changed to use riprap instead of creosoted piling, the latter being found more expensive both to construct and to keep in repair.

The appropriations of 1882, 1886, and nearly all of 1888, were expended upon the dike, building the shore-arm and more than half of the channel-arm. The appropriation of 1884 was expended in dredging

under a special project for widening the channel above Long Wharf with depths of 8 and 12 feet, and for removing part of the old piers and abutments at Tomlinson's Bridge, which bridge was at that time being rebuilt.

The present project for making a 16-foot channel across Fort Hale Bar includes the completion of the dike and dredging a channel 400 feet wide and 16 feet deep through the bar. Revised estimates for completion, made in 1887 (see Annual Report of the Chief of Engineers for 1887, Part I, pages 599 and 600) placed the cost of completion at that time as $46,000 for the dike and $47,000 for the channel; total $93,000. This is to be reduced by $15,000 since appropriated, making the present estimate for completion $78,000.

Up to July 1, 1889, the shore-arm and 1,769 linear feet of the channel-arm of the dike had been built; no dredging had been done on the Fort Hale Bar since that of 1873.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1890.

The contract for extending the Sandy Point Dike, which was in progress at the beginning of the fiscal year, was completed August 29, 1889; since July 1, 1889, 5,379 tons of riprap have been placed in the dike, increasing its length by 320 feet. The total amount of stone placed in the dike under this contract was 10,460 tons, and the dike was extended 730 feet.

The channel above Long Wharf is frequently crowded with barges awaiting a berth for unloading, and in October it was represented by the harbor commissioners that relief was much needed at once. Authority was granted by the Chief of Engineers to expend the available balance (about $2,000) in dredging with a plant hired in open market. Under this arrangement work was begun December 2, and completed December 21, 1889, the dredging-plant having worked thirty-six and one-sixtieth hours at the rate of $55.53 per hour; 11,308 cubic yards of material were taken out, and two cuts 16 feet deep, 40 feet wide each, and respectively 950 and 525 feet long were made on the northwest side of the channel, extending northeasterly from Canal Dock; the longer cut lapped over the sloping edge of the old channel about 20 feet.

PRESENT CONDITION OF IMPROVEMENT.

The available depth over Fort Hale Bar is about 13 feet at mean low water. Above this bar there is a 16-foot channel up to Tomlinson's Bridge, at the head of the harbor, with from 400 to 600 feet width.

Of the Sandy Point Dike the shore-arm, 2,140 feet long, and 2,089 feet of the channel arm (including an ice-breaker 20 feet long) have been built; 1,294 feet of the inner end of the shore-arm are of riprap; the outer part of the shore-arm, 846 feet long, and 254 feet at the north end of the channel-arm, are built of two rows of creosoted piling 8 feet apart from out to out, and filled in with stone; 1,815 feet of the channel-arm south of the pile-work are built of riprap, of which the north 273 feet are on a log foundation; the ice-breaker at the north end of the channel-arm is also of heavy riprap on log foundation.

PROPOSED OPERATIONS.

Future appropriations will be applied to extending the dike or to dredging in the channel or both. The estimated cost of completing

these works is $78,000, to which should be added an estimate of $5,000, annually required for maintenance of channels and repair of dike.

Appropriations for the improvement of New Haven Harbor have been made as follows:

Application.	Date.	Amount.
Removal of Middle Rock, not expended until 1867	Aug. 30, 1852	$6,000
Removal of rocks	July 11, 1870	15,000
Dredging (13 feet) above Fort Hale	Mar. 3, 1871	40,000
Dredging (16 feet) Fort Hale Bar, and removal of rocks	June 10, 1872	35,000
Dredging (16 feet) Fort Hale Bar	Mar. 3, 1873	25,000
Dredging (13 feet) above Long Wharf	Mar 3, 1875	10,000
Dredging (16 feet) Long Wharf to Fort Hale	June 18, 1878	25,000
Dredging (16 feet) above Long Wharf	Mar. 3, 1879	15,000
....do	June 14, 1880	15,000
Dredging (16 feet) Long Wharf to Fort Hale	Mar. 3, 1881	15,000
Sandy Point Dike	Aug. 2, 1882	30,000
Dredging (18, 12, and 8 feet) above Long Wharf	July 5, 1884	10,000
Sandy Point Dike	Aug. 5, 1886	20,000
Do	Aug. 11, 1888	15,000
Total		276,000

New Haven, the port of entry for the collection district of New Haven, is situated at the head of New Haven Harbor, about 3½ miles from Long Island Sound.

There is a light-house on the southwest ledge, at the mouth of the harbor. Fort Hale, 2 miles below the city, commands the channel.

Money statement.

July 1, 1889, amount available	$1,159.88
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	989.24
July 1, 1890, balance available	170.64
Amount appropriated by act of September 19, 1890	15,000.00
Amount available for fiscal year ending June 30, 1891	15,170.64
Amount (estimated) required for completion of existing project	63,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	63,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of contract for extending dike in New Haven Harbor, Connecticut, in force during the fiscal year ending June 30, 1890.

Name and address of contractor.	Date of contract.	Subject of contract.	Price per ton of riprap.	Remarks.
John Beattie, Leete's Island, Conn.	Jan. 19, 1889	Delivery of raprap granite and building dike.	$1.18	Contract completed Aug. 29, 1889.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1889.

Foreign.

Value of imports	$275,379.94
Value of exports	$1,350,892.00
Revenue receipts	$88,746.30
Foreign vessels—entered, 30; cleared, 15; total	45
Domestic vessels—entered 812; cleared, 732; total	1,544

Coastwise.

	Tons.	Value.
Coal received	750,000	$3,375,000
Iron received	100,000	1,800,000
Lumber received 75,000,000 feet	120,000	2,250,000
Miscellaneous merchandise received	864,000	99,370,000
Miscellaneous merchandise shipped	441,250	88,250,000
Totals	2,275,250	195,045,000

Vessels arriving and departing.

Steamers	25,200
Sailing vessels	18,032
Barges	10,800
Totals	54,032

The total amount in tons of freights for the year 1888 was not reported; it is estimated that the tons carried in 1889 were about 250,000 more than in 1888.

By separation of one of the older towing companies into two distinct companies a new towing and transportation line was established during the past fiscal year.

D 6.

CONSTRUCTION OF BREAKWATER AT NEW HAVEN, CONNECTICUT.

New Haven Harbor is the only natural harbor of any considerable area and depth in Long Island Sound between New London Harbor, 45 miles east, and Huntington Bay, 32 miles southwest. At this point Long Island Sound is at its widest, and the broad, open mouth of the harbor left the anchorage ground exposed to storms from a southerly quarter so that vessels driven in by stress of weather were frequently obliged to cross Fort Hale Bar, going from 2 to 4 miles up the harbor, and to anchor in the dredged channel in order to reach secure shelter.

PROJECT.

December 15, 1874, the harbor commissioners of New Haven addressed a memorial to the members of Congress from Connecticut asking that measures be taken "to procure appropriations by Congress for deepening the main ship-channel of the harbor to 20 feet, and for constructing a breakwater from the light-house (then on Five-Mile Point) to Southwest Ledge." The memorial, printed in House Ex. Doc. No. 162, Forty-third Congress, second session, stated that the breakwater contemplated would add greatly to the value of the harbor as a harbor of refuge.

January 21, 1875, a resolution was passed by the House of Representatives asking "for a report, from surveys already made, in regard to the expediency of widening and deepening the main channel of New Haven Harbor, Connecticut, to a depth not exceeding 20 feet, and also the expediency and estimate of expense of a breakwater between the eastern shore of the entrance of said harbor and Southwest Ledge, so called, or such part of said distance as may be found most expedient or necessary for the protection of said harbor." In reply to this resolution a report was made by Col. J. W. Barlow, Corps of Engineers, dated January 27, 1875, printed in House Ex. Doc. above mentioned, and also

in the Annual Report of the Chief of Engineers for 1875, Part II, page 251, suggesting three locations for a breakwater, viz:

1. That indicated in the resolution and terminating at Southwest Ledge.

2. A line running nearly east and west, its middle point resting upon Adam's Fall Rock, about one-half a mile north of Southwest Ledge.

3. A line 400 yards further north, running nearly west from Five-Mile Point.

Estimates of cost ranging from $248,000 to $465,330 were submitted and with the report were also presented letters and commercial statistics bearing upon the subject.

The question of a westerly breakwater does not appear to have been considered at that time.

This report is referred to by Colonel Barlow in the succeeding annual reports for 1876, 1877, and 1878, and in the latter year additional statistics were submitted, but no action was taken until 1879, when an appropriation of $30,000 was made "for the construction of a breakwater at New Haven, Conn."

In August of the same year an examination of part of the mouth of the harbor was made, and a map transmitted to the Chief of Engineers with several projects for breakwaters, which were referred to the Board of Engineers for report.

The report of the Board, dated November 24, 1879, and printed in the Annual Report of the Chief of Engineers for 1880, Part I, pages 449 to 452, recommended a breakwater from Southwest Ledge to Quixes Ledge, as contemplated in the resolution of the House of Representatives of January 21, 1875; but as the anchorage-ground would still be exposed to southwesterly gales, the Board stated that as its opinion a breakwater extending northwest from Luddington Rock would be necessary. Their plan provided for two riprap breakwaters, 12 feet wide on top, rising 6 feet above high water, with exterior slopes of one on three and interior slopes of two on three, with estimates as follows:

Estimates for breakwater from Light-House Ledge to Quixes Ledge.

Length of construction, yards	1,100
Average height of work, feet	32
Average cross-section, yards	299
Cost per cubic yard	$2
328,900 cubic yards, at $2	$657,800

Estimates for Breakwater in the vicinity of Luddington Rock.

Length, yards	1,400
Average height, feet	28
Cross-section, square yards	233⅓
326,667 cubic yards, at $2	$653,334

This plan locates the easterly breakwater so as to lie between Light-House Ledge (or Southwest Ledge) and Quixes Ledge, and the westerly one to extend in a northwest and southeast direction, overlying Luddington Rock. The report of the Board was transmitted to the Secretary of War by the Chief of Engineers, with the suggestion that the appropriation ($30,000) be applied toward the construction of the easterly breakwater, and was approved by him January 31, 1880. Before work had been begun, the details of cross-section were modified with the approval of the Chief of Engineers, so that the exterior slope should be 1 on 2 and the interior 1 on 1.

The first load of stone was delivered April 22, 1880, beginning the east breakwater at the end resting upon Southwest Ledge; under subse-

quent appropriations it was extended northeasterly, and up to July 1, 1889, 3,170 linear feet of the east breakwater had been built, using 267,265 tons of riprap.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1890.

The contract with John Beattie, dated January 7, 1889, which was in progress at the beginning of the fiscal year was completed October 30, 1889; under this contract during the year 14,397 tons of riprap granite were placed in the breakwater, extending it 280 linear feet; the total amount of stone delivered under this contract was 30,464 tons, and the total length of breakwater built, 580 feet.

Under authority of the Chief of Engineers dated April 19, 1889, stone was purchased in open market after the contract was completed, the price being the same as under the contract. From November 2, 1889, to February 22, 1890, 12,115 tons of granite were so purchased and were used in enlarging the cross-section of the breakwater to its full projected dimensions.

The total amount of stone delivered in the breakwater during the fiscal year was 26,512 tons, used in adding 280 linear feet to the work and in enlarging its cross-section.

PRESENT CONDITION OF WORK.

The east breakwater was completed February 22, 1890; it is 3,450 feet long, extending from the foundation of the light-house on Southwest Ledge northeasterly to and across Quixes Ledge, terminating in a depth of 16 feet of water at the edge of the east entrance channel. It contains 293,777 tons of riprap, and the average cost (supervision, etc., included) has been $102.50 per linear foot.

The whole work is in good condition.

PROPOSED OPERATIONS.

The river and harbor act of August 11, 1888, provided:

And the Chief of Engineers may, if deemed necessary, relocate the western breakwater; and the Secretary of War is authorized, in his discretion, to expend any portion of said sum in commencing its construction.

An examination in reference to this matter was made in the fall of 1888, and the results reported to the Chief of Engineers in a letter dated January 26, 1889, and printed in the Annual Report of the Chief of Engineers for 1889, part 1, page 679 *et seq.* The estimated cost of a harbor such as would meet the wishes of the New Haven harbor commissioners is $5,000,000. So large an expenditure does not seem to be warranted by the present demands of commerce. At the same time the harbor as designed in 1879 is not of sufficient capacity, and is now exposed to southerly and southwesterly storms. Vessels will not lie at anchor immediately behind the easterly breakwater, owing to the existence of submerged rocks having over them a minimum depth of 5 feet, so that the anchorage-ground which it really protects is that above Five Mile Point, which is limited in area, and the use of which, by vessels seeking shelter, interferes with the channel to the wharves at New Haven. What is needed is a harbor easily accessible, whose occupation will not interfere with the local harbor. They should be two distinct harbors.

The entrance to the harbor, according to the plan of 1879, between Luddington Rock and Southwest Ledge is 3,500 feet wide. The width is unnecessarily great, and might be reduced without interfering with the free passage of vessels, and better protection be afforded the harbor

From personal examination I am of the opinion that the present and prospective demands of commerce for a long time to come would be met by changing the location of the westerly breakwater to the southwestward about 6,000 feet, and constructing a breakwater crossing Luddington Rock on a course S. 54° W., commencing at a point 1,000 feet N. 54° E. from Luddington Rock, and extending S. 54° W. 5,000 feet, leaving an opening of 2,000 feet or less between its western end and the southern end of the westerly breakwater in its proposed change of location. The location of these works is shown on a sketch printed with the Annual Report of the Chief of Engineers for 1889 (part 1, page 678). The cost in addition to the present estimate of $1,311,134 will be about $750,000. The space behind the breakwater proposed through Luddington Rock is free from obstructions, and has a depth of from 15 to 20 feet, with good holding ground; it can be reached at the eastern end with a depth of 17 feet, and at the western end with a depth of 28 feet.

This work should commence at Luddington Rock and extend in both directions, as funds are provided. The rock which now forms an obstruction will be covered by the breakwater, and a permanent beacon at the eastern end will, with the light-house on Southwest Ledge, clearly mark the entrance. The entrance then will be 2,500 feet wide, with a minimum depth of 17 feet, and a maximum of 25 feet.

For the better protection of the harbor the space between the easterly breakwater and the shore, a distance of 2,000 feet, should be partly closed by a breakwater extending from the shore towards the eastern end of the easterly breakwater, leaving an opening in the present eastern channel, 13 feet deep, of 800 feet. The cost of this is estimated at $90,000; it is not so important as the works proposed on the western side of the harbor, and may be deferred until they are completed.

With future appropriations it is proposed to construct the westerly breakwater in accordance either with the original plan or with such relocation as may be made by the Chief of Engineers under the special authority conveyed by Congress.

Appropriations for the New Haven Breakwater have been made as follows:

Application.	Date.	Amount.
Easterly breakwater	Mar. 3, 1879	$30,000
Do	June 14, 1880	30,000
Do	Mar. 3, 1881	60,000
Do	Aug. 2, 1882	60,000
Do	July 5, 1884	40,000
Do	Aug. 5, 1886	75,000
Completing easterly breakwater	Aug. 11, 1888	75,000
Total		370,000

New Haven, the port of entry for the collection district of New Haven, is situated at the head of New Haven Harbor, about 4 miles north of the breakwater.

There is a light-house on Southwest Ledge, the west terminus of the east breakwater.

Fort Hale, 2 miles north of the breakwater, commands the harbor channel.

Money statement.

July 1, 1889, amount available		$23,435.31
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$7,764.83	
July 1, 1890, outstanding liabilities	175.00	
		7,939.83
July 1, 1890, balance available		15,495.48
Amount appropriated by act of September 19, 1890		120,000.00
Amount available for fiscal year ending June 30, 1891		135,495.48
Amount (estimated) required for completion of existing project		821,134.00
Amount that can be profitably expended in fiscal year ending June 30, 1892 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		500,000.00

Abstract of contract for breakwater at New Haven, Conn., in force during the fiscal year ending June 30, 1890.

Name and address of contractor.	Date of contract.	Subject of contract.	Price per ton.	Remarks.
John Beattie, Leete's Island, Conn.	Jan. 7, 1889	Delivery of riprap granite and construction of breakwater.	$1.22	Contract completed Oct. 30, 1889.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR, 1889.

Vessels passing New Haven Breakwater.

Kind.	Number.	Kind.	Number.
Men-of-war	35	Schooners and sloops	54,290
Steam-ships	2,460	Barges in tow	32,400
Steamers of all kinds	40,475		
Ships, barks, and brigs	1,080	Total	130,740

This is 64,490 more vessels than reported for the previous year. In neither case are the records complete, as many vessels pass unobserved in night or in thick weather. The tonnage and value of this commerce can not be ascertained.

D 7.

IMPROVEMENT OF MILFORD HARBOR, CONNECTICUT.

This harbor is on the north shore of Long Island Sound, about 9 miles southwest of New Haven, Conn. It consists of a broad, open bay, from the head of which the Wepauwog River, a small tidal stream, extends three-quarters of a mile north to the Milford wharves, and the Indian River, another small inlet, extends northeasterly. The mouth of the latter stream is partly closed by a dam formerly used to create power for a tide-mill.

The original depth on the bar just outside the mouth of the rivers was less than 2 feet at mean low water, and in some places between there and the upper wharves low tide left the channel nearly bare.

The mean rise of tide is 6.2 feet.

PROJECTS FOR IMPROVEMENT.

A survey of breakwater at Milford, Conn., was ordered by Congress in the river and harbor act of 1872. There being no breakwater, a survey of the harbor was made for a breakwater, and in his report, dated December 24, 1874 (printed as part of Ex. Doc. No. 107, Forty-second Congress, third session, and also on page 1041 of the Annual Report of the Chief of Engineers for 1873), General Warren, U. S. Engineers, submitted the following plan of improvement:

1. A riprap breakwater from Welch's Point, on the east side of the mouth of the harbor	$67,000
2. Protecting the bluffs on the east shore from erosion by means of small stone jetties	5,500
3. Dredging 4 feet deep and 100 feet wide across the bar at the mouth of the river	6,250
4. A jetty on the east side of the channel, to prevent the dredged area from filling, and to confine the action of the tide	5,000
Superintendence	1,250
Total	85,000

In 1874, $5,000 was appropriated for this harbor, and work under the above project was begun, building the small jetties, to protect the east shore. Twelve such jetties were built 100 to 130 feet long, and rising to 9 feet above mean low-water line. The appropriation of 1875 ($13,000) was applied to the repair of these jetties, to construction of a jetty from the east shore, at the mouth of Indian River (Long Jetty), and to dredging across the bar.

In the Annual Report for 1876 (see Annual Report of the Chief of Engineers for 1876, part 1, page 225), Colonel Barlow, U. S. Engineers, recommended that the dredged channel be carried up to the town wharf, about a half mile farther, at an additional estimated cost of $9,000.

This recommendation was renewed in 1877, and was included in the project for expenditure of the appropriation of $10,000 made in 1878. In that and the following year the 4-foot channel across the bar was completed to 100 feet width as originally projected, and was extended to Town Wharf with width from 60 to 75 feet, and Long Jetty was repaired; also under the same appropriation, in 1879 and 1880, an additional jetty, authorized by Department letter of October 16, 1889, was built on the west side of the channel extending southward from Burns's Point. This appropriation completed the original project except the breakwater; sufficient money for beginning that had not been appropriated.

June 14, 1880, $5,000 was appropriated, and in accordance with a project for its expenditure submitted and approved, the 4-foot harbor channel was extended from Town Wharf to the Straw Works Wharf, at the upper end of the harbor, with a width of 40 feet. This was completed before the appropriation was exhausted, and "at the earnest solicitation of those most interested in the works of improvement there, an experimental channel, 25 feet wide and 8 feet deep, was cut through the bar at the entrance lying within and on the west side of the channel already made. This is now of great use to the steam-vessels employed in the fish-oil works at that place, and it is claimed that the increase of shipping in the harbor, particularly in the oyster business, for which those waters seem very well adapted, will soon require an 8 foot channel of fully 100 feet width. Such a channel would involve the removal of about 45,000 cubic yards more of material, principally sand and

gravel, which, at ruling prices, would cost, including superintendence and incidental expenses, about $11,000." (Extract from Colonel Barlow's annual report of 1881. See Annual Report of the Chief of Engineers for 1881, part 1, pages 598 and 599.)

Under the appropriation of $5,000, made August 2, 1882, the project above suggested was adopted and the 8-foot channel was widened to 65 feet from the bay up to Merwin's Wharf, with 100 feet width around the bend at Burns's Point. In 1889 this channel was made fully 100 feet wide, and some needed repairs to Long Jetty were begun.

By act of Congress approved March 3, 1881, a survey for a breakwater and harbor of refuge at Milford Harbor was authorized. The survey was made, and a report, with estimates, was submitted January 20, 1882. This report is printed in the Annual Report of the Chief of Engineers for 1882, part 1, page 332.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1890.

In August, 1889, 10 tons of stone were removed from near the channel and placed upon Long Jetty; the funds available were not sufficient to continue the repair of jetties.

Under date of December 14, 1889, Hon. O. H. Platt, United States Senate, wrote the Chief of Engineers requesting an examination of Milford Harbor and a report upon dredging the channel to the upper wharves. This report was made December 31, 1889. In compliance with a resolution of the House of Representatives of January 18, 1889, a copy of the report was transmitted to the House, and it was printed as House Ex. Doc. No. 139, Fifty-first Congress, first session. A copy of the report and accompanying papers is also attached to this report.

PRESENT CONDITION OF IMPROVEMENT.

The channel, dredged 4 feet deep, with width of 60 feet for about two-thirds the distance from the mouth of the river to the Straw Works Wharf, and width of 40 feet for the rest of the distance, has shoaled somewhat.

The channel across the bar is now 8 feet deep and over 100 feet wide.

Long Jetty, on the east bank at the mouth of the Indian River, needs further repairs; the other jetties need slight repairs.

PROPOSED OPERATIONS.

Future appropriations should be applied to repairing the jetties and maintaining the channels already dredged. A recent estimate places the cost of properly repairing the jetties at about $2,500. Nothing will be needed for maintaining the channel during the ensuing year.

Appropriations for Milford Harbor have been made as follows, viz:

Application.	Date.	Amount.
Survey	June 10, 1872	$1,500
Jetties on east shore	June 22, 1874	5,000
Long Jetty and dredging at mouth of river	Mar. 3, 1875	13,000
Dredging to Town Wharf	June 18, 1878	10,000
Dredging above Town Wharf and (8 feet) below Merwin's Wharf on bar	June 14, 1880	5,000
Survey for breakwater	Mar. 3, 1881	100
Dredging 8 feet on bar	Aug. 2, 1882	5,000
Dredging 8 feet on bar and repairing Long Jetty	Aug. 11, 1888	5,000
Total		44,600

Milford Harbor is in the collection district of New Haven; it is about 9 miles west from Fort Hale, New Haven Harbor. The nearest light-house is on Stratford Point, 4 miles to the westward.

Money statement.

July 1, 1889, amount available	$1,404.35
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,332.40
July 1, 1890, balance available	71.95
Amount appropriated by act of September 19, 1890	2,500.00
Amount available for fiscal year ending June 30, 1891	2,571.95
Amount (estimated) required for repairs	2,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	2,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1889.

Vessels arriving and departing.

	Number.	Tonnage.
Steamers	2,160	129,600
Sailing vessels	460	23,000
Barges	12	3,000
Total	2,632	155,600

The chief articles of commerce are coal, lumber, oysters, and general merchandise, amounting in the aggregate to about 11,000 tons, carried by water.

The amount of freight reported for this harbor in 1889 is about the same as that for the previous year.

No new lines of transportation have been established at Milford Harbor since the last Annual Report.

SPECIAL REPORT ON EXAMINATION OF MILFORD HARBOR, CONNECTICUT.

LETTER OF HON. O. H. PLATT, UNITED STATES SENATE.

COMMITTEE ON TERRITORIES,
United States Senate, December 14, 1889.

MY DEAR SIR: Will you kindly order an examination of Milford Harbar, Connecticut, to be made by Colonel Houston; and a report to you as to the necessity and advisability of dredging out the channel to the upper wharves, and the amount that would be required for that work, and let me know the result.

Very truly yours,

O. H. PLATT, *U. S. S.*

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF COLONEL D. C. HOUSTON, CORPS OF ENGINEERS.

[Second indorsement.]

ENGINEER OFFICE, U. S. ARMY,
Army Building, New York, December 31, 1889.

Respectfully returned to the Chief of Engineers.

The river and harbor act of August 11, 1888, appropriated $5,000 for Milford Harbor, "to complete the improvement." This referred to the partial project submitted in 1881 for dredging an 8-foot channel through the bar and up to Merwin's Wharf, at an estimated cost of $11,000. This project has been completed and some repairs have been made to Long Jetty. In my Annual Report for 1889 I submitted an estimate of $2,500 for completing those repairs.

The original project for the improvement of this harbor was:

1. For breakwater at Welch's Point, to consist of riprap granite, in pieces of a ton and upward in weight, to have a triangular cross-section sloping 45° each side and rise 9 feet above mean low water, and to extend from the shore out to the curve of 15 feet depth, being 890 feet long, and requiring 24,290 tons, at $2.50	$60,725
Superintendence	6,275
Total	67,000
2. For protecting 2,100 feet of the east shore of the harbor from erosion by small jetties made with rocks lying on the shore, about 100 feet apart, extending from highest water out as far as low water and raised to the height of high water, twenty jetties, at $250 each	5,000
Add for superintendence	500
	5,500
3. To dredge a channel across the bar at the mouth of the Wepauwog River to a depth of 4 feet and a width of 100 feet, 25,000 cubic yards, at 25 cents	6,250
To prevent filling up again requires a jetty on the east side, which will also help to confine the action of the tide to the channel-way. This to be built of piles and riprap stone for a length of 550 feet, at an estimated cost of	5,000
Add for superintendence, etc	1,250
Total	12,500
Making a total for all purposes at Milford Harbor of	85,000

It also contemplated the improvement of the harbor up to the head of navigation in Milford. The following appropriations have been made and expended in improving this harbor:

June 23, 1874	$5,500	August 2, 1882	$5,000
March 3, 1875	13,000	August 11, 1888	5,000
June 18, 1878	10,000		
June 14, 1880	5,000	Total	43,000

The east bluff has been protected from erosion by means of small jetties; the jetty on the east side of the channel, "Long Jetty," has been built; and the channel has been dredged 8 feet deep and 100 feet wide up to Merwin's Wharf, thence 4 feet deep and 60 feet wide to Town Wharf, and thence 4 feet deep and 40 feet wide to the Straw Works Wharf, at the head of navigation.

A revised estimate of $87,000 was made for the breakwater in 1882 (Annual Report of the Chief of Engineers for 1882, Part I, page 632). Owing to small appropriations no work has been done on the proposed breakwater. By reference to these projects it will be seen that the *object of* the breakwater was to provide a harbor of refuge exterior to

the harbor proper at Milford. As the breakwaters constructed and proposed at the entrance to New Haven Harbor (only 7 miles east of Welch's Point), since the project for Milford Harbor was made, will provide a capacious harbor of refuge, there is no longer any necessity for a breakwater at Welch's Point.

The 4-foot channel dredged in 1878–'80 was not deep enough to be of much benefit to navigation. It is claimed that if the channel were deepened to 8 feet at mean low water the additional depth would be utilized, and a regular steamer would be run between Milford and New York City. The cost of making the channel 8 feet deep at mean low water and 100 feet wide is estimated at $30,000.

I inclose a letter from Mr. W. B. Brotherton, chairman of a committee of citizens in reference to the needs of this harbor.

D. C. HOUSTON,
Colonel of Engineers.

LETTER OF MR. W. B. BROTHERTON.

UNITED STATES POST-OFFICE,
Milford, Conn., December 24, 1889.

DEAR SIR: Yours of the 20th received in regard to commercial statistics of Milford Harbor above Merwin's Wharf.

In reply, would say that it is impossible for me to give much of a report, for the reason that I have not kept a record of arrivals and departures of vessels above the point mentioned. I know that there have been a number of vessels to the upper or town wharves during the year when they have happened to strike the tide right and have water enough, but ordinarily they all have to stop at Merwin's Wharf. You must have some report of the number. You understand, of course, that being obliged to stop so far down near the mouth of the harbor necessitates a long pull on the part of our merchants and manufacturers of all merchandise coming by water.

Another matter that our people have in view, provided we get our channel shape, and that is putting on a small steamer to run between here and New York, to carry freight principally. This project has been considered for some time, but has never been pushed by our business men for the reason that we had such a poor channel, and in the event of putting on a boat she would be getting aground every time she came in, and that, of course, would necessitate lightering and expense, to say nothing of the delay and vexation.

What is desired is a channel about 100 feet wide and 8 feet deep at low water, then we could get along very nicely. What the expense would be I do not know; but one thing I do know, it would be a great accommodation to the four thousand inhabitants of Milford, besides a part of the town of Orange, that depends upon Milford for some of its supplies.

Please excuse the lengthy letter, but I have been compelled to be rather long-winded in order to have you understand in any way our situation. In a nut-shell, we have demands, but we lack facilities.

Yours, very respectfully,

W. B. BROTHERTON.

Col. D. C. HOUSTON,
Corps of Engineers.

D 8.

IMPROVEMENT OF HOUSATONIC RIVER, CONNECTICUT.

The Housatonic is a long shallow river, running southward through Massachusetts and Connecticut and emptying into Long Island Sound just east of Stratford Point, about 15 miles southwest from New Haven. At Derby, 13 miles above its mouth, it receives the discharge of the Naugatuck, a small rapid river. This point, which has been regarded as the head of navigation, is nearly the head of tide-water. About a

mile above there is a dam across the Housatonic River furnishing large water-power. For at least 5 miles below Derby the water is always fresh.

The original depth on the worst bars in the river (six in number) was from 3.5 to 4.5 feet at mean low water; there was also a bar across the river's mouth with about 4 feet low-water depth.

PROJECTS FOR IMPROVEMENT.

In pursuance of a resolution of the House of Representatives, dated December 20, 1869, authorizing a survey of the Housatonic River below Derby, which resolution was referred by the Secretary of War to the Chief of Engineers for report as to the "necessity for the survey," an examination of the river from Derby to Long Island Sound was made by Col. D. C. Houston, Corps of Engineers, who reported January 8, 1870, recommending a detailed survey of all that part of the river at an estimated cost of $5,000. This report was printed in House Ex. Doc. No. 62, Forty-first Congress, second session.

By act of Congress approved July 11, 1870, a survey of Housatonic River below Derby, Conn., was directed, and an allotment of $2,700 was made for a survey "sufficient to determine the prominent obstructions to navigation." In his report on this survey, dated January 23, 1871, and printed in House Ex. Doc. No. 95, Forty-first Congress, third session, also in the Annual Report for 1871, page 781, General G. K. Warren, Corps of Engineers, submitted the following estimates for making a channel 7 feet deep at mean low water, to be 200 feet wide over the bar at the mouth of the river, and 150 feet wide in the river, the channel at the river's mouth to be protected on the east side by a breakwater from Milford Beach:

Jetty at Sow and Pigs Reef	$4,000
Removing Drew's Rock, 357 cubic yards	2,000
Dredging inside the bar at the mouth	18,486
Dredging on the bar at the mouth	12,000
Construction of breakwater at mouth	368,475
Total	404,961

The breakwater was to be built of riprap up to 1½ feet above mean low water and of dimension stone above; it was to be 6 feet wide on top, rising to 11 feet above low water, and was to extend to the 6-foot curve, an estimated length of 4,200 feet.

March 3, 1871, the first appropriation for improvement of the river was made and work in accordance with the project was begun. In 1872 the project was modified to admit of a jetty connecting Drew's Rock with the west bank, instead of removal of the rock. This was done on the ground of economy, and the jetty was built in 1872. The result has been to form a bar below the jetty, which required such frequent dredging that it was found expedient to remove the rock as originally projected. This was done in 1887–'88.

Appropriations were not made in sufficient amount to warrant beginning the breakwater as originally designed, and in 1879 Colonel Barlow proposed to substitute for it a riprap jetty at an estimated cost of $12,000. In 1882 the estimate was changed to $20,250, the contemplated jetty being 6,000 feet long and rising only to low-water level. Such a jetty could subsequently be built higher, if necessary, and there seems no doubt that this would have to be done before any useful effect could be realized. Therefore, in my annual report for 1887 (see Annual

Report of the Chief of Engineers for 1887, Part I, page 607), I presented revised estimates for a breakwater, modifying the originally proposed method of construction to one for using riprap only, experience at harbors on Long Island Sound having shown this construction to be as durable as dimension work and more economical.

At the same time estimates based on recent surveys were submitted for the dredging necessary to make the channel 7 feet deep with width of 200 feet at the mouth of the river and 100 feet above. The latter width was adopted in 1883, because, up to that time, the originally proposed width of 150 feet had never been obtained.

Following are the estimates for the breakwater and for dredging submitted in 1887:

For a breakwater 5,750 feet long, extending from Milford Beach 3,250 feet in a course about south-southeast, thence parallel with and 500 feet from the channel, 2,500 feet further to the 12-foot curve; inside the bend to be built up to 3 feet above mean low water, top width 6 feet, side slopes 1 on 1; outside the bend to be built up to 6 feet above high water, top width 12 feet, outer slope 1 on 2, and inner slope 1 on 1	$175,000
For dredging at the mouth of the river and at six bars in the river, 146,000 cubic yards, at 16 cents, with about 15 per cent. added for contingent expenses	27,000
Total	202,000

To which should be added about $4,000 annually required for maintenance of channels.

January 27, 1888, a letter further explaining the reasons for the new estimate for breakwater was submitted to the Chief of Engineers, and was subsequently printed as Senate Ex. Doc. No. 103, Fiftieth Congress, first session, and also in the Annual Report of the Chief of Engineers for 1888, Part I, page 554.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1890.

The act of Congress of August 11, 1888, appropriated $35,000 for improving this river and provided that $25,000 of such sum "may be expended in commencing the construction of a breakwater at the mouth of said river."

A contract was entered into May 17, 1889, with William H. Morton, for delivering riprap granite and constructing the breakwater as required, at the rate of $1.49 per ton of stone. Work under this contract was begun July 10, was suspended for the winter November 27, 1889, was resumed May 28, 1890, and is still in progress. Up to July 1, 1890, 5,063 tons of granite have been delivered and the length of breakwater built is 1,200 feet, beginning above high-water mark on Milford Beach.

A contract for hire of dredging plant, crew, etc., was entered into April 9, 1889, with Richard Parrott, at the rate of $8.50 per hour; with a guarantied rate of work of 50 yards per hour when the bank was sand of 3 feet depth or more. The contract required that work should begin not later than June 10, 1889. The contractor was unable to comply with this requirement, and as it was important the work should be done as early in the season as practicable, the contract was annulled and under authority of the Chief of Engineers a dredge was hired in open market from the Hartford Dredging Company, the rate of payment being $9 per hour and the guarantied rate of work being 55 cubic yards per hour where the cutting was sand 3 feet deep. Under this arrangement work was begun August 7, and completed November 4,

1889, 35,674 cubic yards of sand, mud, and clay being removed. The dredging was done as follows:

	cu. yds.
Two-Mile Island Bar	10,217
Camp-Meeting Bar	6,279
Mill Bar	8,533
Bend below Stratford	10,645
Total	35,674

The number of hours worked was 706$\frac{32}{60}$, and the average per hour was 50$\frac{1}{2}$ cubic yards; clay and logs were removed from some of the bars, thereby reducing the rate per hour. The channels were made 80 feet wide and from 7 to 8 feet deep at mean low water.

PRESENT CONDITION OF IMPROVEMENT.

The present available depth on the several bars in the river and on the bar at the mouth of the river is not less than 6 feet at mean low water.

PROPOSED OPERATIONS.

Under the contract now in force the breakwater will be extended to a length of about 3,300 feet.

With future appropriations it is proposed to widen and maintain the river channels, to complete the breakwater, and to deepen and maintain the channel on the bar at the river's mouth, as provided in the project.

The estimated cost of completing the work is $167,000, to which should be added about $4,000 annually for maintenance of dredged channels.

Appropriations for the Housatonic River have been made as follows, viz:

Application.	Date.	Amount.
Examination	Mar. 2, 1867	$42
Survey	July 11, 1870	2,700
Sow and Pigs' jetty; dredging	Mar. 3, 1871	15,000
Drew's Rock jetty; dredging	June 10, 1872	15,000
Dredging	Mar. 3, 1873	10,000
Do	June 23, 1874	10,000
Do	Mar. 3, 1875	5,000
Do	June 18, 1878	5,000
Do	June 14, 1880	2,000
Do	Mar. 3, 1881	2,000
Removing Drew's Rock and jetty in 1887	Aug. 2, 1882	2,000
Do	July 5, 1884	2,500
Do	Aug. 5, 1886	5,000
Commencing breakwater; dredging	Aug. 11, 1888	35,000
Total		111,242

The Housatonic River is the boundary between the collection districts of New Haven and Fairfield. The nearest work of defense is Fort Hale, New Haven Harbor, about 15 miles east. The nearest light-house is on Stratford Point at the mouth of the river.

Money statement.

July 1, 1889, amount available		$8,131.18
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$2,907.20	
July 1, 1890, outstanding liabilities	90.00	
		2,997.20
July 1, 1890, balance available		5,133.98
Amount appropriated by act of September 19, 1890		35,000.00
Amount available for fiscal year ending June 30, 1891		40,133.98

Amount (estimated) required for completion of existing project $132,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892 100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of contract for the construction of breakwater at the south of Housatonic River Connecticut, in force during the fiscal year ending June 30, 1890.

Name of contractor.	Date of contract.	Subject of contract.	Price per ton.	Remarks.
Wm. H. Morton, New York City.	May 17, 1889	Delivery of riprap granite and construction of breakwater.	$1.49	In progress; contract extended to July 30, 1890.

COMMERCIAL STATISTICS FOR CALENDAR YEAR 1889.

At Derby, head of navigation.

Vessels arriving and departing.	Number.	Tonnage.
Steamers	520	104,300
Sailing vessels	878	90,400
Barges	725	181,250
Total	2,123	375,950

Freight received and shipped.	Tons.	Value.
Lumber, 2,500,000 feet, being about	4,000	$60,000
Coal	30,000	157,680
Copper	12,000	3,120,000
Paper	27,000	10,800
Iron	15,000	375,000
Miscellaneous received	88,500	10,000,000
Miscellaneous shipped	49,000	5,000,000
Total	225,500	18,723,480

At Stratford, near mouth of river.

Vessels arriving and departing.	Number.	Tonnage.
Large vessels:		
Steamers	2,200	132,000
Sailing vessels	720	43,200
Barges in tow	60	15,000
Small vessels:		
"Oystermen" (sail)	12,600	37,800
Total	15,580	228,000

Freights received and shipped.	Tons.	Value.
Coal	18,000	$90,000
Oysters	5,000	125,000
Oyster-shells	17,000	68,000
Miscellaneous merchandise	39,470	986,750
Total	79,470	1,269,750

The total tonnage of river freight in 1889, as shown by the above reports, was 304,970 tons, being about 101,000 tons less than that reported for the previous year.

No new lines of transportation have been established upon this river during the fiscal year ending June 30, 1890.

D 9.

IMPROVEMENT OF BRIDGEPORT HARBOR, CONNECTICUT.

This harbor extends nearly 3 miles inland from the north shore of Long Island Sound, its width of about 1 mile at the mouth decreasing to 200 feet between opposite wharves at its upper end. The channel, even in the widest part of the harbor, is comparatively narrow.

Before the first work by the United States was done at this harbor the depth over the bars, at the harbor's mouth, was about 5 feet at low water, equivalent to 11½ feet at high water, and the low-water depth above the bridges was from 2 to 7 feet.

PROJECTS FOR IMPROVEMENT.

In 1833 a petition of citizens of Bridgeport was presented to Congress asking an appropriation of $10,000 to improve the harbor. This was granted in 1836, and the agent in charge was instructed by the Engineer Department to dredge a channel 8 feet deep, making it 200 feet wide through the outer bar and 100 feet wide through the inner bar, or as much as the appropriation would admit of. The work was done by contract in 1837; the rate was high (understood to be 72.8 cents per cubic yard) and the funds were exhausted when the channel through the outer bar had been made 60 feet wide.

In 1838 Captain Swift, U. S. Engineers, reported that the channel had been sounded and was found to be 12 feet deep, or 4 feet deeper than when left by the dredger.

Nothing further was done until 1852, when a second appropriation of $10,000 was made. Captain Dutton, U. S. Engineers, found that the channel on the outer bar was then 6 feet deep and 90 feet wide, and on the inner bar but 5 feet deep, and he submitted a project for dredging through both bars to a depth of 8 feet and a width of 200 feet, at a total estimated cost of $32,000. This project was approved by the Secretary of War, February 5, 1853, and with the $10,000 then available channels 8 to 13 feet deep were dredged 100 feet wide through the inner bar and 60 feet wide through the outer bar.

By act of Congress approved June 23, 1866, a survey of the harbor was ordered, which was made in that year. The object of the survey was to ascertain "the present state of the harbor and the character and extent of the encroachments upon it by the action of the tides," it being feared that Long Beach, on the east side of the harbor's mouth, was making northwestward by reason of sand drifting along the shore in such a way as to contract and ultimately fill up the channel above the inner bar. This work was at that time in my charge, and in my report on the survey, dated January 12, 1867, I stated that it had been proposed to construct a breakwater, extending out from Long Beach, to arrest the sand, but the danger feared did not seem imminent, and I recommended a series of observations for the purpose of ascertaining the nature and amount of changes taking place.

In 1867 a survey of the shore-line of Long Beach was made.

In 1868 I was directed by the Chief of Engineers to make "such resurvey of Bridgeport Harbor, Connecticut, as may be found necessary to ascertain what changes have occurred since the survey of 1866." In my report on this survey I said that the channel remained the same, and that no appropriation was needed until "the channel is found to be inadequate to the necessities of commerce, and then dredging must be resorted to."

In 1870 a petition of citizens of Bridgeport was presented to Congress asking that an appropriation "be made to remove said sand-bar" (the outer bar) "and to widen and deepen said channel and harbor in order that vessels drawing 12 feet of water may be enabled to enter without being grounded and without the aid of lighters," and a survey or examination of the harbor was ordered.

The work was then in charge of General Warren, U. S. Engineers. He made an examination of the harbor and found it unnecessary to make further surveys. In his report, dated January 12, 1871, General Warren submitted a project for dredging a channel 100 feet wide and 12 feet deep at extreme low water (or 14 feet at mean low water) and for building a pier 3,000 feet long extending out from Long Beach, to be partly of riprap, partly of dolphins. The estimated cost of the project was $124,000. After an appropriation of $20,000 was made in 1871, work under this project was begun, dredging to depths of 12 and 13 feet at mean low water, and substituting a riprap jetty for riprap and dolphins. The jetty was completed as far as deemed necessary in 1873.

In 1875 the dimensions of the projected channel were modified so as to make it 12 feet deep at mean low water and from 200 to 300 feet wide. This was accomplished in 1882.

In 1878, in compliance with the terms of the appropriation act of that year, a channel 100 feet wide and 9 feet deep was dredged from the lower bridge to the horse-railroad bridge, a distance of about 3,000 feet.

After the appropriation of 1882, a project for widening to 600 feet the channel between the inner beacon and the Naugatuck Railroad Wharf was adopted to prevent overcrowding of the main channel by vessels entering to seek refuge during storms; the estimated cost was $60,000. This is nearly completed, a small area near the inner beacon remaining to be dredged.

In November, 1887, a petition was sent to the Secretary of War, signed by the mayor and other citizens of Bridgeport, asking that $10,000 be appropriated for a channel 8½ to 9 feet deep and 100 feet wide above the horse-railroad bridge. This petition, with indorsements and report estimating $18,000 as the cost of such work, is printed in the Annual Report of the Chief of Engineers for 1889, part 1, pages 697–699. The appropriation act of 1888 authorized this work and the project was therefore extended to include it.

March 8, 1889, a petition was addressed to the Secretary of War by the mayor and other citizens of Bridgeport, representing the necessity of a breakwater within the harbor of Bridgeport. This petition with indorsements is printed in the Annual Report of the Chief of Engineers for 1889, Part I, pages 700–702; the indorsements estimate the cost of a breakwater from the Tongue to the inner beacon at about $30,000, and authorize the extension of the project to include this work.

The project for improving this harbor, as thus extended, consists—

First.—In dredging, to make and maintain a channel 12 feet deep at mean low water and 300 feet wide or more, from Long Island Sound to

the lower bridge, nearly completed; estimated cost to complete, $17,000.

Second.—In dredging, to make and maintain a channel 9 feet deep and 100 feet wide from the lower bridge to the head of the harbor, partly completed; estimated cost to complete, $8,000.

Third.—In building a breakwater from the Tongue to the inner beacon, not yet begun; estimated to cost $30,000.

It is probable that ultimately an extension of the east breakwater will be required.

Up to July 1, 1889, 34,054 cubic yards of mud had been removed from the channel above the horse-railroad bridge under a contract then in progress.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1890.

The contract with A. J. Beardsley & Son for dredging above the horse-railroad bridge, which was in progress at the beginning of the fiscal year, was completed July 16, 1889. After July 1, 1889, 10,946 cubic yards of material were removed from the channel, making the total amount dredged under the contract 45,000 cubic yards. A channel was dredged 9 feet deep at mean low water from the horse-railroad bridge to within 100 feet of Black's Wharf, with width of 90 feet for the first 400 feet and 75 feet for the remaining 1,400 feet.

PRESENT CONDITION OF IMPROVEMENT.

The 12-foot channel is 75 feet wide on the outer bar, but for 200 feet width there is a depth of 11 feet or over; thence across the inner bar and up to the inner beacon the 12-foot channel is about 300 feet wide; thence up to the Naugatuck Railroad Wharf it is 600 feet wide; from that wharf to the lower bridge it has shoaled so that the present depth is from 10 to 11 feet.

The channel from the lower bridge to the horse-railroad bridge, dredged 9 feet deep and 100 feet wide in 1878, retains nearly that depth and width; the 9-foot channel above the horse-railroad bridge is 1,400 feet long, and as stated above.

The breakwater at Long Beach has settled since it was built in 1871–'73; it still serves the purpose for which it was designed, and no repairs are now needed.

The project of 1882 for making 600 feet width of channel between the inner beacon and the Naugatuck Railroad Wharf was reported completed in 1887; the inner beacon has since been rebuilt and its location slightly changed, which makes it desirable to cut off a short point outside the new position of that beacon; this was partly done in 1888.

PROPOSED OPERATIONS.

With future appropriations it is proposed to complete the channel above the bridges, to remove the shoal places above the Naugatuck Railroad Wharf, and to widen the channel eastward to the harbor line, an additional width of about 200 feet; also to construct a breakwater from the Tongue to the inner beacon. The estimated cost of the above work is $55,000; it could be done to advantage in a single year.

The annual cost of maintaining the dredged channels in this harbor is estimated at $3,000.

Appropriations for the improvement of Bridgeport Harbor have been made as follows:

Application.	Date.	Amount.
Dredging outer bar	July 4, 1836	$10,000.00
Dredging outer and inner bars	Aug. 30, 1852	10,000.00
Survey	June 23, 1866	1,985.38
Do	July 11, 1870	500.00
Dredging and 521 feet of breakwater	Mar 3, 1871	20,000.00
Dredging and 859 feet of breakwater	June 10, 1872	40,000.00
Dredging inner bar and upper harbor	Mar. 3, 1873	30,000.00
Dredging bridge to Long Island Sound (9 feet)	June 23, 1874	20,000.00
Dredging bridge to Long Island Sound (12 feet)	Mar. 3, 1875	15,000.00
Dredging upper harbor (9 feet)	Aug. 14, 1876	10,000.00
Dredging above bridge and outer bar (9 and 12 feet)	June 18, 1878	10,000.00
Dredging bridge to Long Island Sound (12 feet)	Mar. 3, 1879	10,000.00
Do	June 14, 1880	10,000.00
Dredging above inner beacon (12 feet)	Mar. 3, 1881	10,000.00
Dredging between inner beacon and railroad wharf (12 feet)	Aug. 2, 1882	10,000.00
Do	July 5, 1884	5,000.00
Do	Aug. 5, 1886	30,000.00
Dredging above horse-railroad bridge (9 feet)	Aug. 11, 1888	10,000.00
Total		242,485.38

Bridgeport, the port of entry for the collection district of Fairfield, is situated about 2 miles from Long Island Sound, at the head of Bridgeport Harbor. There is a light-house at the entrance to the harbor. Fort Hale, New Haven Harbor, the nearest work of defense, is 18 miles east.

Money statement.

July 1, 1889, amount available	$2,438.87
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,110.12
July 1, 1890, balance available	1,328.75
Amount appropriated by act of September 19, 1890	20,000.00
Amount available for fiscal year ending June 30, 1891	21,328.75
Amount (estimated) required for completion of existing project	35,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	35,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of contract for dredging in Bridgeport Harbor, Connecticut, in force during the fiscal year ending June 30, 1890.

Name of contractor.	Date of contract.	Subject of contract.	Price per cubic yard.	Remarks.
A. J. Beardsley & Son, Bridgeport, Conn.	Feb. 4, 1889.	Dredging	$0.18	Contract completed July 16, 1889.

COMMERCIAL STATISTICS FOR CALENDAR YEAR 1889.

Arrivals and departures of vessels—draught 6 to 18 feet.

	Number.	Tonnage.
Foreign commerce:		
Arrivals	7	888
Departures	8	1,006
Domestic commerce:		
Arrivals and departures	17,250	1,335,860
Total	17,265	1,337,754

Cargoes.

	Tons.	Estimated value.
Receipts	1,702,827	$41,500,000
Shipments	314,330	40,000,000
Total	1,017,157	81,500,000

During 1889 4,196 vessels carrying 219,000 tons cargoes entered the harbor for refuge.

The commercial statistics reported for 1888 did not give the tonnage of cargoes; parties best competent to judge estimate that the business of the harbor in 1889 was about 15 per cent. greater than during the previous year.

No new lines of transportation were established in this harbor during the fiscal year ending June 30, 1889.

D 10.

IMPROVEMENT OF BLACK ROCK HARBOR, CONNECTICUT.

This harbor, 1½ miles long from northeast to southwest and from 300 to 2,500 feet wide, lies between the mainland on the west and Fairweather Island on the east, and includes the navigable part of Cedar Creek, a small tidal inlet which extends up into the western part of the city of Bridgeport, and affords water communication of great value to several large manufactories in its immediate neighborhood. It is in the interest of the city of Bridgeport that the improvement of Black Rock Harbor is desired.

The depth in the lower part of the harbor is from 6 to 12 feet at mean low water. This part of the harbor was formerly much used as a refuge for vessels overtaken by storms, but is not deep enough for most vessels now engaged in commerce through the Sound. Before work was done in Cedar Creek the depth there was from 2 to 4 feet and the channel was narrow and crooked.

The head of the harbor was separated from Long Island Sound on the southeast by a broad, flat sand-bar, which was bare at about half-tide, and which joined Fairweather Island with the main shore.

PROJECTS FOR IMPROVEMENT.

Between 1836 and 1838, $21,500 were expended in building a sea-wall across a breach in the southern part of Fairweather Island to preserve the light-house reservation at the south end of the island, and to prevent shoaling on the anchorage ground.

In 1882 a survey of the harbor was ordered by Congress, which was made in 1883. In his report on this survey, dated December 12, 1883, Colonel McFarland, U. S. Engineers, submitted a project providing—

(1) For protecting the upper part of the harbor from the sea by building a breakwater over the bar northeast of Fairweather Island, to be about a half mile long and 6 feet wide at the top, which was to be 3½ feet above mean high water, or 10 feet above low water.

(2) For making a channel 80 feet wide and 6 feet deep at mean low water, extending up Cedar Creek.

The estimated cost was:

Breakwater	$58,000
Dredging	22,000
Total	80,000

Work under this project was begun in 1885, and up to July 1, 1889, the breakwater had been built to its full length in order to prevent the currents from cutting a channel across the bar, but its cross-section was less than designed, both in height and width; also a channel 6 feet deep, or over, had been dredged with width of 80 feet up to the Forge Company's wharf in Cedar Creek, and extended about 430 feet farther, with a width of 30 to 40 feet.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1890.

Under the appropriation of $10,000 made by act of Congress of August 11, 1888, a contract, dated April 23, 1889, was entered into with J. H. Fenner, to dredge in Cedar Creek, Black Rock Harbor, above the Forge Company's wharf, at a rate of 16 cents per cubic yard. Work under this contract was begun October 5 and completed October 26, 1889, 50,000 cubic yards being removed, making a channel 80 feet wide and 6 feet deep at mean low water, extending from the Forge Compan's wharf northward about 2,200 feet to within 500 feet of Iranistan avenue, at the head of the harbor.

Measurement was made in the bank, based upon a channel survey made in August, 1889, for the purpose, and only material dredged from above the required depth was accepted. The dredged material was pumped up through pipes and deposited upon the marsh meadows at considerable distance back from high-water mark.

After the completion of the Government contract dredging was continued in the same manner by private parties, chiefly for the sake of obtaining the material for filling. The channel was widened at the bend about a quarter of a mile below the Forge Company's wharf, and it is understood that it was widened and deepened in other parts.

From June 10 to June 23, 1890, the channel east of the Middle Ground was made 135 feet wide and 7 feet deep at mean low water, and the channel opposite the Marine Railway, Black Rock, was widened 70 feet. The work was done as an open market transaction, 8,000 cubic yards of sand being dredged from the channel at a cost of $800.

PRESENT CONDITION OF IMPROVEMENT.

The sea-wall built in 1836–1838 across a breach in Fairweather Island is still effective in preserving the island and preventing the sea from washing over into the harbor. It needs some repair.

The breakwater between Fairweather Island and the mainland is built to its full length, 2,744 feet, with diminished cross-section.

The 6-foot channel has been dredged to the full width and length projected; it has shoaled at the sides so that in a few places the available width is now less than 80 feet.

PROPOSED OPERATIONS.

With future appropriations it is proposed to build up the breakwater to the dimensions projected, and to maintain and widen the present channel, as becomes necessary; $20,000 could be profitably expended on this work during the next fiscal year.

Appropriations for the improvement of Black Rock Harbor have been made as follows:

Application.	Date.	Amount.
Building sea-wall on Fairweather Island	1836–1838	$21,500
Survey	Aug. 2, 1882	350
Building breakwater and dredging	July 5, 1884	20,000
Dredging	Aug. 5, 1886	5,000
Do	Aug. 11, 1888	10,000
Total		56,850

Black Rock Harbor is in the Fairfield collection district, of which Bridgeport is the port of entry. There is a light-house at the harbor entrance. Fort Hale, New Haven Harbor, the nearest work of defense, is 20 miles east.

Money statement.

July 1, 1889, amount available		$2,084.56
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$748.13	
July 1, 1890, outstanding liabilities	875.00	
		1,623.13
July 1, 1890, balance available		461.43
Amount appropriated by act of September 19, 1890		5,000.00
Amount available for fiscal year ending June 30, 1891		5,461.43
Amount (estimated) required for completion of existing project		40,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892		20,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of contract for improving Black Rock Harbor, Connecticut, in force during the fiscal year ending June 30, 1890.

Contractor.	Date of contract.	Subject of contract.	Price per cubic yard.	Remarks.
J. H. Fenner, Jersey City, N.J	Apr. 23, 1889	Dredging	$0.16	Contract completed Oct. 28, 1889.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1889.

Received and shipped by water.

	Tons.	Value.
Coal	28,400	$142,000
Iron and steel	2,490	80,000
Miscellaneous	485	11,000
Total	31,365	233,000

Vessels used in above traffic.

[Draught, 6 to 11 feet.]

Steamers	236
Sailing vessels	108
Barges	250
Total	594

In addition to the above 2,030 vessels anchored in Black Rock Harbor for refuge during 1889.

The above statement shows an increase in tonnage of 3,865 tons above that reported for the year 1888.

No new lines of transportation have been established in this harbor during the past year.

D 11.

IMPROVEMENT OF NORWALK HARBOR, CONNECTICUT.

Norwalk Harbor, or River, is a tidal estuary, with a narrow channel extending about 3 miles north from Long Island Sound to the town of Norwalk. Above Norwalk the river is a small fresh-water stream. South Norwalk is on the west bank of the river, 1½ miles below Norwalk. At this point the river is crossed by two draw-bridges, the lower one a highway bridge, and the other (450 feet above) the bridge of the New York, New Haven and Hartford Railroad.

In 1867 a company was incorporated under the laws of the State of Connecticut for the improvement of the river. Little work was done, and when improvement was begun by the United States, the low-water depth to South Norwalk was 5 feet and to Norwalk but 1 foot.

PROJECTS FOR IMPROVEMENT.

By act of March 2, 1829, Congress appropriated $80 "for making a survey of the harbor of Norwalk, Conn., with a view to its improvement." The survey was made by Capt. Hartman Bache, U. S. Engineers, who, in his report on the same dated May 10, 1830, recommended excavating the channel, proposing to build a steam-dredge for the purpose. The cost was estimated as follows:

For a channel 12 feet deep at ordinary high water	$15,668.95
For a channel 10 feet deep at ordinary high water	12,286.45

No money was appropriated for carrying out this plan, and in 1871 another survey was ordered by Congress, which was made in the same year. In his report upon the latter survey, dated December 16, 1871, and printed in Senate Ex. Doc. No. 23, Forty-second Congress, second session, also in the Annual Report of the Chief of Engineers for 1872, page 900, General Warren, U. S. Engineers, submitted a project for dredging a channel 6 feet deep and 100 feet wide from Long Island Sound up to Norwalk, at an estimated cost of $34,000.

In 1880, the terms of the river and harbor act provided that "so much of said appropriation ($5,000) as shall be necessary therefor shall be so expended as to have a channel 6 feet deep at low water between the steam-boat landing in said Norwalk and Long Island Sound. As a channel of the projected width (100 feet) and depth of 6 feet at *mean* low water already existed, this was interpreted as requiring a depth of 6 feet at *extreme* low water (see Annual Report of the Chief of Engineers for 1881, Part 1, page 609), which would be 8 feet at mean low water, and the project was accordingly modified to provide for obtaining that depth up to South Norwalk, where the steam-boat landing was.

The latest estimate, made to include the cost of this modification, and of a large amount of dredging already required to maintain the channel, places the total cost from the time of beginning work at $84,000.

Up to July 1, 1889, the channel below South Norwalk had been

dredged 100 feet wide and 8 feet deep at mean low water; above South Norwalk the channel was from 60 to 100 feet wide and 6 feet deep.

March 3, 1888, a letter was sent by the Hon. William P. Frye, United States Senator, to the Secretary of War, asking that a special examination of Norwalk Harbor be made with reference to a developing business which urgently required further improvements. There was no money available for a detailed examination, but inquiry was made and estimates, based upon charts of the United States Coast Survey, were submitted for the desired improvements, which consisted of dredging at Wilson's Point, at the western approach to Norwalk Harbor. The letter to the Secretary of War, with indorsements, was printed in the Annual Report of the Chief of Engineers for 1889, Part 1, page 709.

The act of Congress of August 11, 1888, appropriated $28,000 for continuing the improvement of Norwalk Harbor, with the following provision:

> Twenty-five thousand dollars of which shall be expended in dredgiug and deepening the channel in the lower harbor up to Wilson's Point.

Up to July 1, 1889, the channel at Wilson's Point had been dredged 15 feet deep at mean low water and 200 feet wide for about two-thirds the distance required.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1890.

Under the contract for dredging at Wilson's Point, work was suspended from April 20, 1889, to August 7, 1889, when it was resumed, and the contract was completed November 9, 1889. During the past fiscal year 95,591 cubic yards of material were dredged, making the total amount removed under the contract 205,586 cubic yards. The width of channel (of 15 feet depth at mean low water) was increased to 400 feet, and the channel was extended out to deep water in Long Island Sound.

PRESENT CONDITION OF IMPROVEMENT.

In the river, the channel below South Norwalk, which has been made 100 feet wide and 8 feet deep at mean low water, is in fair condition, the width being slightly less on account of caving and washing of the banks. Above South Norwalk the channel is 6 feet deep, and from 60 to 100 feet wide.

At Wilson's Point, the channel close to the docks is 12 feet deep, dredged by the railroad company; outside of this is a channel 15 feet deep and 400 feet wide, extending out to the curve of 15 feet depth.

PROPOSED OPERATIONS.

The channel at Wilson's Point is completed as far as designed, and no further appropriation is now required at that place. The cost of completing this work was much lower than estimated, partly by reason of the unusually low rates obtained for dredging, partly because a large amount of work upon the channel had been done by the Railroad Company since the estimate.

The estimated amount to complete work in the river is $4,000; this could be advantageously expended during the ensuing year in restoring and maintaining the channels already dredged. It seems unnecessary

and inexpedient at present to attempt to make and maintain a width of 100 feet above South Norwalk.

Appropriations for improving Norwalk Harbor have been made as follows:

Application.	Date.	Amount.
Survey	Mar. 2, 1829	$80.00
Do	Mar. 3, 1871	1,166.66
Dredging (6 feet) above South Norwalk	June 10, 1872	10,000.00
Do	Mar. 3, 1873	10,000.00
Do	June 23, 1874	10,000.00
Dredging (6 feet) below South Norwalk	Mar. 3, 1875	7,000.00
Do	June 18, 1878	6,000.00
Dredging (6 feet) above and below South Norwalk	Mar. 3, 1879	10,000.00
Dredging (6 feet) below South Norwalk	June 14, 1880	5,000.00
Dredging (8 feet) below and (6 feet) above Norwalk	Mar. 3, 1881	5,000.00
Dredging (6 feet) above South Norwalk	Aug. 2, 1882	5,000.00
Dredging (8 feet) below South Norwalk	July 5, 1884	5,000.00
Dredging (6 feet) above South Norwalk	Aug. 5, 1886	3,000.00
Dredging (6 feet) above and (8 feet) below South Norwalk, and $25,000 in dredging 15 feet deep at Wilson's Point	Aug. 11, 1888	28,000.00
Total		105,246.66

Norwalk is in the Fairfield collection district, and is 11 miles west of Bridgeport, the port of entry.

Norwalk light-house is on Sheffield's Island, at the harbor entrance.

The nearest work of defense is Fort Schuyler, Throg's Neck, at the head of Long Island Sound, about 29 miles southwest.

Money statement.

July 1, 1889, amount available		$9,839.48
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$8,788.36	
July 1, 1890, outstanding liabilities	91.50	
		8,879.86
July 1, 1890, balance available		959.62
Amount appropriated by act of September 19, 1890		4,000.00
Amount available for fiscal year ending June 30, 1890		4,959.62

Abstract of contract for improving Norwalk Harbor, Connecticut, in force during the fiscal year ending June 30, 1890.

Name and address of contractor.	Date of contract.	Subject of contract.	Price per cubic yard.	Remarks.
A. J. Beardsley & Son, Bridgeport, Conn.	Jan. 15, 1889	Dredging at Wilson's Point.	$0.11	Contract completed Nov. 9, 1889.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR OF 1889.

AT NORWALK AND SOUTH NORWALK.

No statement of commerce of the Norwalk River for 1889 has yet been received. It is probably not far from that of 1886, when the receipts and shipments amounted to 438,600 tons, carried by 2,370 vessels of 9 to 10 feet draught.

AT WILSON'S POINT.

Freight received and shipped by water.

	Tons.	Value.
Coal	35,500	$145,000
Miscellaneous	70,650	Unknown.
Total	106,150	

Arrivals and departures of vessels.

[Draught, 11 to 17 feet; tonnage, 195 to 1,350 tons.]

Sailing vessels	26
Barges	60

The above statement shows an increase of tonnage since 1888 of 11,915 tons.
No new lines of transportation have been established since the last Annual Report

---

D 12.

IMPROVEMENT OF FIVE MILE RIVER HARBOR, CONNECTICUT.

This harbor is an inlet on the north shore of Long Island Sound, about 2 miles west of the mouth of Norwalk Harbor, Connecticut. It is about 1 mile long and from 300 to 800 feet wide. About three-quarters of a mile above its mouth it runs bare at low tide. At the mouth the depth is about 3 feet, increasing to 9 feet at a point about 750 feet out into the sound.

The mean rise of tide is about 7 feet.

Since 1848 Five Mile River has been largely engaged in oyster-growing, and in this business now employs about one hundred and twenty-five vessels.

These vessels can only enter or leave the harbor at high tide; consequently during their busy seasons they are obliged to lie up for the night at other and less convenient harbors.

PROJECT FOR IMPROVEMENT.

By act of Congress approved August 5, 1886, a survey or examination of this harbor was ordered, which was made in the following fall and reported on under date of December 7, 1886, and printed in the Annual Report of the Chief of Engineers for 1887, Part I, page 639.

In this report a project for improvement was proposed, which consisted in dredging a channel 8 feet deep at mean low water and 100 feet wide, to extend up the harbor and to be about 6,000 feet long; the estimated cost was $25,000. This project was adopted in 1888, when work under it was ordered by the appropriation of $5,000 made by act of Congress of August 11, 1888.

Up to July 1, 1889, 10,976 cubic yards had been dredged under this project, and the contract was in progress.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1890.

The dredging, in progress at the beginning of the fiscal year, under contract for hire of plant, crew, etc., dated April 9, 1889, was completed

August 15, 1889. Since July 1, 1889, 11,962 cubic yards were dredged during two hundred and sixty-three working hours. The total amount dredged under the contract was 22,938 cubic yards, and the total number of hours' work was four hundred and seventy.

An examination of the dredged channel and of the harbor was made shortly after the completion of the work.

PRESENT CONDITION OF IMPROVEMENT.

The dredged channel is 1,500 feet long, about 50 feet wide, and 8 feet deep at mean low water, extending from the 8-foot curve in Long Island Sound up the harbor; above the dredged channel the depth is 2 feet or less. This dredged channel represents the work done under the contract of April 9, 1889, being the only work ever done towards improving this harbor.

PROPOSED OPERATIONS.

With future appropriations it is proposed to complete the channel as projected, and for this work $10,000 could be profitably expended during the ensuing fiscal year.

The only appropriation made for this harbor is the one of $5,000 by act of Congress of August 11, 1888, expended as above described.

Five Mile River is in the Fairfield collection district, and is about 13 miles west of Bridgeport, the port of entry. The nearest light-house is on Sheffield's Island, nearly 2 miles from the mouth of the harbor. The nearest work of defense is Fort Schuyler, at the head of Long Island Sound, 27 miles southwest.

Money statement.

July 1, 1889, amount available	$2,756.97
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	2,577.72
July 1, 1890, balance available	179.25
Amount appropriated by act of September 19, 1890	5,000.00
Amount available for fiscal year ending June 30, 1891	5,179.25
Amount (estimated) required for completion of existing project	15,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	10,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of contract for improving Five Mile River Harbor, Connecticut, in force during the fiscal year ending June 30, 1890.

Contractor.	Date of contract.	Subject of contract.	Price per working hour.	Remarks.
Richard Parrott, Newburgh, N. Y.	Apr. 9, 1889	Hire of dredging plant, crew, etc.	$8.50	Contract completed Aug. 15, 1889.

COMMERCIAL STATISTICS FOR CALENDAR YEAR 1889.

Bushels of oysters raised	600,000
Value of oysters raised	$360,000
Steamers employed	22
Sail-vessels employed	100
Value of vessels	$200,000
Draught of vessels ranges from ... feet	2 to 7½
Tonnage ... tons	5 to 150

The business done in this harbor does not depend upon the number of tons of freight carried, but upon the amount and value of the oysters raised. It was about the same in 1889 as in the previous year.

No new lines of transportation have been established since the last annual report.

D 13.

IMPROVEMENT OF STAMFORD HARBOR, CONNECTICUT.

This is a small harbor on the north shore of Long Island Sound, about 6 miles east of the New York State line. The harbor consists of a bay about a mile long and a mile broad, and of the mouth of the Mill River, a small stream which is dammed at Oliver Street Bridge, the head of the harbor. The original low-water depth for a mile below the bridge was from 1 to 3 feet in a crooked channel, and the 6-foot curve in the bay was about 6,600 feet below the bridge; the wharves are all in the upper half of this distance.

The mean rise of the tide is 7.9 feet.

PROJECTS FOR IMPROVEMENT.

By act of March 2, 1829, Congress appropriated $100 for "making a survey of the harbor of Stamford, Conn., with a view to its improvement."

The survey was made by Capt. Hartman Bache, U. S. Engineers, in 1829; in his report on the same, dated May 10, 1830, Captain Bache recommended excavating the channel (proposing to build a steam-dredge for the purpose), the cost being estimated as follows:

For a channel 12 feet deep at ordinary high water (about 4 feet at mean low water)	$13,250.00
For a channel 10 feet deep at ordinary high water	11,035.20

No money was appropriated for carrying out this plan.

The river and harbor act of 1882 authorized a survey of this harbor, which was made in the following year. In his report on this survey, dated December 12, 1883 (printed in Senate Ex. Doc. No. 50, Forty-eighth Congress, first session; also in the Annual Report of the Chief of Engineers for 1884, Part I, page 672), Colonel McFarland, U. S. Engineers, submitted a project for dredging a channel 80 feet wide and 5 feet deep at mean low water from deep water in the bay up to Oliver Street Bridge, estimated to cost as follows:

Dredging 80,000 cubic yards of mud at 20 cents	$16,000
Contingencies	4,000
Total	20,000

It was not intended to include the removal of the ledge under and just below the bridge.

The beginning of the work under this project was approved by the Secretary of War August 30, 1886, after the first appropriation for improving the harbor had been made.

Up to July 1, 1889, the channel had been dredged 5 feet deep at mean low water, with width of 80 feet for the lower half of its projected length, and 50 feet wide above.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1890.

The available funds were insufficient to carry on the work of improvement, and nothing was done.

PRESENT CONDITION OF IMPROVEMENT.

From the bend below Flint Rock up to within 1,200 feet of Oliver Street Bridge the 5-foot channel is 80 feet wide or over; above that point it is 50 feet wide.

For about 500 feet below Flint Rock, at the entrance to the dredged channel, the natural depth is from 1 to 5 inches short of 5 feet and the bottom is very soft. Here the channel has not been dredged yet.

PROPOSED OPERATIONS.

Future appropriations will be applied to completing the project; $5,000, the remainder of the original estimate, could be profitably expended for this purpose during the next fiscal year.

Appropriations for improving Stamford Harbor have been made as follows:

Application.	Date.	Amount.
Survey	Mar. 2, 1829	$100
Do	Aug. 2, 1882	350
Dredging	Aug. 5, 1886	10,000
Do	Aug. 11, 1888	5,000
Total		15,450

Stamford Harbor is in the Fairfield collection district of which Bridgeport is the port of entry. There is a light-house on the Middle Ground at the harbor entrance. The nearest work of defense is Fort Schuyler, Throg's Neck, New York, 20 miles to the southwest.

Money statement.

July 1, 1889, amount available	$630.34
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	116.48
July 1, 1890, balance available	513.86
Amount appropriated by act of September 19, 1890	5,000.00
Amount available for fiscal year ending June 30, 1891	5,513.86

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1889.

Arrivals and departures of vessels.

[Draught, 5 to 12 feet; tonnage, 10 to 375 tons.]

Steamers	151
Sailing vessels	376
Barges	137

Freight received and shipped by water.

	No. cargoes.	Tons.	Value.
Coal	65	15,625	$78,152
Lumber and baryta	60	18,000	36,000
Miscellaneous	426	11,485	118,915
Total	551	46,110	233,067

The above does not include what comes into Stamford via "the canal," a private channel.

Since the last annual report no new lines of transportation have been established; the statistics furnished show an increase of 14,349 tons freight since the calendar year 1888.

D 14.

IMPROVEMENT OF PORT CHESTER HARBOR, NEW YORK.

This harbor consists of the lower part of the Byram River, and a bay at its mouth opening into Long Island Sound. The river for about 1½ miles from its mouth forms the boundary line between the States of New York and Connecticut. It was formerly navigable to within a few hundred feet of the bridge at Port Chester, a little more than a mile above the mouth.

Before improvement the available depth up to the wharves was about 1 foot at mean low water. The mean rise of the tide is 7.4 feet.

PROJECTS FOR IMPROVEMENT.

A survey of the harbor was made in 1871, and a project for improvement based on it was submitted and adopted. The project provided for the removal of two rocks, Sunken Rock, at the entrance to the bay, with 5.7 feet low-water depth, to be removed to 11 feet, and Salt Rock, about 1,000 feet above the mouth of the river, partly bare at low water, to be removed to 9 feet depth; it also provided for a breakwater 400 feet long at Byram Point The estimated cost was as follows:

Sunken Rock, 1,474.5 cubic yards, at $40	$58,980
Salt Rock, 316.3 cubic yards, at $40	12,652
Breakwater at Byram Point	25,000
Total	96,632

Under this project Salt Rock was removed in 1873. No further work was done until 1884, when a survey of the channel was made under the appropriation of August 2, 1882, and a project for expending the funds available in 1884 (about $16,000) was submitted and approved. It provided for making a channel from 60 to 100 feet wide, and 2½ feet deep at mean low water, from the bay to the vicinity of the bridge at Port Chester. This modification was made in deference to the wishes of the business men of Port Chester. The channel was completed to within 150 feet of the bridge in May, 1885. In 1886 9,232 cubic yards of sand and gravel were dredged, straightening the channel and removing small lumps and irregularities.

Under the appropriation of $5,000, made in 1888, the project was modified to omit the removal of Sunken Rock, and to change the location of the proposed breakwater, making it extend from Sunken Rock towards the shore. Sunken Rock was dangerous only because it was submerged, and was at the side of the channel; the channel width at the rock was ample. A breakwater with the end on the rock rising some distance above high water would serve as a beacon, and would be an aid intead of a danger to navigation, besides affording more shelter than the originally proposed breakwater; thus it would take the place both of the breakwater and of the removal of Sunken Rock, together estimated to cost $83,980.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1890.

The available funds were insufficient to continue the improvement and no work was done.

PRESENT CONDITION OF IMPROVEMENT.

Salt Rock has been removed.

An available channel 2½ feet deep at mean low water, and from 60 to 100 feet wide, has been dredged to a point 150 feet below the bridge; thence to the bridge the width is 25 feet. In front of the wharves, where vessels lie aground at low tide, the bottom has been leveled as nearly as practicable.

Two hundred and eighty-eight linear feet of the breakwater have been built with the top 5 feet wide and 1 foot above high water, and with slopes of 1 upon 1; the end of the breakwater resting upon Sunken Rock was built to 5 feet above high water, to serve as a beacon.

PROPOSED OPERATIONS.

With future appropriations it is proposed to extend the breakwater to high-water mark on Byram Point and to maintain the channel up the river.

The estimated cost of completion, hitherto reported as $64,632, is much too large by reason of substituting the breakwater from Sunken Rock to Byram Point, in place of removing the rock. A recent estimate shows that $25,000 will be sufficient to finish the breakwater as now designed and to maintain the present channel, and with the approval of the Chief of Engineers this sum is now adopted as the estimate for completion of the project.

Appropriations for Port Chester Harbor have been made as follows:

Application.	Date.	Amount.
Removing Salt Rock	June 10, 1872	$12,000
Dredging in Byram River and Bay	Aug. 2, 1882	15,000
Breakwater	Aug. 11, 1888	5,000
Total		32,000

Port Chester Harbor is in the collection district of New York. The nearest lighthouse is on Great Captain's Island, 1¼ miles east of the mouth of the harbor. The nearest work of defense is Fort Schuyler, at Throg's Neck, about 15 miles southwest.

Money statement.

July 1, 1889, amount available	$14.71
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	3.50
July 1, 1890, balance available	11.21
Amount appropriated by act of September 19, 1890	5,000.00
Amount available for fiscal year ending June 30, 1891	5,011.21
Amount (estimated) required for completion of existing project	20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	20,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1889.

Arrivals and departures.

[Draught, 5 to 8½ feet. Tonnage, 25 to 300 tons.]

	Number.	Tonnage
Steamers	601	56,000
Sailing vessels	405	22,000
Barges, etc	715	112,000
Total	1,721	190,000

Cargoes.

	Tons.	Value.
Shipments	20,000	$750,000
Receipts	125,000	985,000
Total	145,000	1,735,000

The principal articles of commerce are manufactured goods, coal, iron, building materials, and general merchandise.

The above figures show an increase in tonnage of freights since 1888 of 35,000 tons.

No new lines of transportation have been established at Port Chester Harbor since the last Annual Report.

D 15.

IMPROVEMENT OF ECHO HARBOR, NEW ROCHELLE, NEW YORK.

Echo Harbor is a bay on the north shore of Long Island Sound, distant about 22 miles by water from the Battery at New York. It is landlocked, except toward the southeast, and has a good anchorage. Nearly all of the water transportation of the town of New Rochelle is carried on through this harbor.

The depth in the bay varies from 6 to 15 feet at mean low water, though the low-water channel up to the wharves is only from 1 to 2 feet deep.

The mean rise of tide is 7.3 feet.

PROJECT FOR IMPROVEMENT.

A survey was made in 1875, and a project based on it was submitted December 20, 1875, and subsequently adopted, providing for the removal of two rocky reefs from the channel, viz:

(1) Sheepshead Reef, lying midway between Echo Island and Duck Point, which had 1.6 feet of water upon it at low tide. This was to be removed to a depth of 9 feet at low water, which required the excavation of 872.5 cubic yards of rock, costing	$21,201.75
(2) Start Rock, which projects about 2 feet above low water, and lay in the channel 120 feet from Beaufort Point. This was to be removed to 7 feet below low water, requiring the excavation of 370 cubic yards of rock, costing	12,672.50
Contingencies	5,081.13
Total	38,955.38

A depth of 7 feet over Start Rock was obtained in January, 1880, and in 1881–1883, 506 cubic yards were removed from the southern part of Sheepshead Reef, making 9 feet depth. In May, 1889, a petition of residents of New Rochelle was submitted, asking that the money then available be expended in dredging up to the wharves. This was approved by the Chief of Engineers.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1890.

The expenditure of the available funds in dredging being authorized, the work to be done as an open-market transaction, a dredging plant, with crew, tow-boat, and scows, was hired at the rate of $9.50 per working hour. Work was begun August 21 and completed October 25, 1889, the plant having worked two hundred and eighty-eight hours, and removed 9,122 cubic yards of mud, making a channel 4 feet deep at mean low water and 40 feet wide, extending from deep water to about 300 feet from the head of the harbor, a total length of about 1,050 feet. The material was dumped in small coves north of Echo Island, at request of or with consent of owners of adjacent shores, who proposed filling up the coves. The plant was able to work but a few hours each tide on account of the shoal water both in the channel and at the dumping-ground.

PRESENT CONDITION OF IMPROVEMENT.

Start Rock has been removed to 7 feet depth at mean low water, and about one-half of Sheepshead Reef has been removed to a depth of 9 feet at mean low water.

The dredged channel is as above described, no other dredging than that of last year ever having been done in this harbor by the United States.

PROPOSED OPERATIONS.

To complete the project, there yet remains the removal of the rest of Sheepshead Reef, which can be done with the balance of the original estimate not yet appropriated, $17,000, provided it be available at one time; and it is recommended on the ground of economical expenditure that if further appropriations be made for removal of rocks in this harbor, not less than the estimated sum required be appropriated.

Appropriations for improving Echo Harbor, New Rochelle, N. Y., have been made as follows:

Application.	Date.	Amount.
Removal of Start Rock	June 18, 1878	$10,000
Do	Mar. 3, 1879	3,000
Removal of Sheepshead Rock	June 14, 1880	3,000
Do	Mar. 3, 1881	3,000
Dredging	Aug. 2, 1882	3,000
Total		22,000

Echo Harbor is in the collection district of New York. The nearest light-house is on Execution Rock. The fortifications on Throg's Neck, 7 miles to the westward, are the nearest works of defense.

Money statement

July 1, 1889, amount available	$3,043.97
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	3,043.97
Amount (estimated) required for completion of existing project	17,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	17,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Arrivals and departures of vessels.

	Number.	Tonnage.
Steamers	350	28,000
Sailing vessels	300	24,000
Barges etc	170	34,000
Total	820	86,000

Freights received	tons	86,000
Estimated value		$1,290,000

The principal articles of commerce are coal, building materials, and general merchandise. The New Rochelle Yacht Club, which is largely interested in the removal of rock from this harbor includes about 40 vessels, ranging in size from 60 tons downward.

The above figures show an increase in tonnage of freights of 29,000 tons since 1888. No new lines of transportation have been established during the past year.

D 16.

IMPROVEMENT OF NEW ROCHELLE HARBOR, NEW YORK.

New Rochelle Harbor is situated at the west end of Long Island Sound, on its north shore, about 10 miles west of the boundary between the States of New York and Connecticut; it lies off the southerly part of the town of New Rochelle, while Echo Harbor is off the northerly part. The harbor itself consists of rather narrow and circuitous passages between several rocky islands and reefs, which shelter it from rough weather. The original depth of the main channel in this harbor was from 8 to 9 feet at mean low water; there were two rocks in or near the channel-way whose removal was desired, and the narrowness of the deep-water channel at the head of the harbor made it necessary for steamers to back out.

Glen Island, a popular summer-day resort for excursion and picnic parties from New York City, lies in the middle of this harbor; between the harbor and Long Island Sound lies David's Island, one of the principal recruiting posts for the Army.

The improvement of this harbor was desired chiefly in the interest of Glen Island as a summer resort; no harbor improvement seems to have been needed for David's Island, and the commerce by water for New Rochelle is carried on almost wholly in Echo Harbor.

PROJECTS FOR IMPROVEMENT.

A survey of New Rochelle Harbor was ordered by the act approved June 14, 1880, and made in the same year. In the report of this survey January 28, 1881, a project for improvement was submitted, contemplating the removal of Corning Rock to 12 feet depth at mean low water, of Rock C to 9 feet depth, the dredging of a channel 100 feet wide and 8 feet deep around the south end of Glen Island to connect with the channel around the north end of that Island, and the removal of a reef that obstructed the entrance to this projected channel, the whole being estimated to cost $40,825. The object of this dredging and rock removal was to allow vessels to pass around the island instead of having to turn in the narrow channel.

In 1881 the channel around Glen Island was dredged 100 feet wide and 6 feet deep, and work was begun under a contract to remove the reef at the channel entrance to 8 feet depth. The contract was extended, and in 1883 work was abandoned by the contractor while parts of the rock were still from 1 to 1½ feet above the plane of removal required

In 1883 Corning Rock was removed to 12 feet depth by hired labor, at a cost of about $34 per cubic yard.

A large bowlder was removed from near David's Island Wharf, and 10.6 cubic yards of loose rock were removed from the reef at the entrance to the dredged channel, making a depth of 7.5 feet there.

An examination of the dredged channel and the rocks at the entrance was made in April, 1887. By this examination a reef was discovered, not shown on the original survey, projecting about 40 feet into the proposed channel, with a least depth of 6 feet; also a rock known as Rock B, projecting about 10 feet into the proposed channel, with a least depth of 2.9 feet. Authority was obtained under date of April 30, 1887, to complete the removal of the rocks at the entrance by hired labor, and to deepen the dredged channel to 8 feet depth at mean low water by contract.

The removal of the rock was completed in 1888, making 8 feet depth at mean low water upon Rock B, and a depth of 7½ feet or over upon the above-mentioned reef.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1890.

Authority was received to expend the available funds in dredging, under open-market transaction, and an arrangement was made for doing the work at the rate of 20 cents per cubic yard, material to be deposited in deep water in Long Island Sound east of Eaton's Neck. Work was begun January 10, 1890, and completed March 3, 1890, 40,700 cubic yards of mud being removed from the channel south of Glen Island, making the depth 8 feet at mean low water where it had been from 0 to 6 feet; width of dredged channel 100 feet; length about 1,600 feet.

PRESENT CONDITION OF IMPROVEMENT.

Corning Rock has been removed to 12 feet depth, and the reef at the south entrance to channel around Glen Island has been removed to make a channel 100 feet wide and fully 7½ feet depth; the rest of the channel around Glen Island Island is 8 feet deep and 100 feet wide or over.

PROPOSED OPERATIONS.

The project for improvement is practically completed, except the removal of Rock C; this does not now appear to be necessary, therefore no further work is now proposed.

Appropriations for the improvement of New Rochelle Harbor have been made as follows:

Application.	Date.	Amount.
Dredging and partial removal of rock at mouth of Glen Island Channel	Mar. 3, 1881	$20,000
Removing Corning Rock and dredging	Aug. 2, 1882	15,000
Total		35,000

New Rochelle Harbor is in the collection district of New York. The nearest lighthouse is on Execution Rock. The fortifications at Throg's Neck, 7 miles west, are the nearest works of defense.

Money statement.

July 1, 1889, amount available	$9,026.70
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	8,806.77
July 1, 1890, balance available	219.93

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1889.

Arrivals and departures of vessels.

	Number.	Tonnage.
Steamers	1,900	1,007,000
Barges, etc	96	26,400
Total	1,996	1,033,400

Draught of vessels entering New Rochelle Harbor, 5½ to 11 feet; tonnage, 275 to 640 tons.

Cargoes received, 5,000 tons; estimated value, $125,000. No freight is shipped from this harbor.

Number of passengers transported to and from this harbor during 1889:

By steamers	750,000
By barges	212,000
Total	962,000

The above statement shows 5,850 tons freight less than the statement submitted for the previous year, but an increase of about 250,000 in the number of passengers carried.

No new lines of transportation were established during the past year.

D 17.

IMPROVEMENT OF EAST CHESTER CREEK, NEW YORK.

East Chester Creek, called also Hutchinson's River, is a small stream which, as a tidal inlet for the last 4 miles of its course, traverses marshes of one-quarter to 1 mile in width, and empties into East Chester or Pelham Bay, a large bay on the northwest shore of Long Island Sound,

just east of Throg's Neck, and 20 miles by water from the Battery, New York City. The width of the creek varies from 25 feet to a half mile at high water, but the channel is narrow everywhere.

Pelham Bridge, a highway bridge, crosses the creek near its mouth. A short distance above is the bridge and trestle of the Harlem River branch of the New York, New Haven and Hartford Railroad, and about 2¼ miles above its mouth at Lockwood's the stream is crossed by the Boston road. All three bridges are draw-bridges.

The mean rise of tide at the mouth of the creek is 7, 1.

For half a mile up the creek there was originally a channel from 3 to 9 feet deep at low tide, but the depth decreased farther up, and at Town Dock, the principal landing, about 1½ miles from the mouth, the available depth at high water was only about equal to the rise of the tide. Above Town Dock the stream was narrow and crooked and the depth about the same.

The commerce at Town Dock was principally in coal and building materials for the villages of East Chester and Mount Vernon; the latter is a rapidly growing place, with a present population of about 11,000. The main part of the village is about 2 miles from Town Dock. It is understood to be mainly for the benefit of prospective Mount Vernon commerce that the improvement of East Chester Creek is desired.

PROJECTS FOR IMPROVEMENT.

In 1871 a survey of East Chester Creek was ordered by Congress; it was made in the same year, and in the report, dated January 19, 1872, and printed in the Annual Report of the Chief of Engineers for 1872, page 812, three plans of improvement were outlined, viz:

For making and maintaining, by means of a tidal basin and system of dikes, a channel 9 feet deep at mean low water, estimated to cost $1,646,000.

For making and maintaining in the same way a channel of 11 feet deep at mean high water (about 4 feet deep at low water), estimated to cost $731,000.

For securing 7 feet depth of slackwater navigation by means of a lock above Goose Island (about half a mile from the mouth of the creek), estimated to cost $300,000.

No recommendation as to the worthiness of improvement accompanied these estimates. March 25, 1872, the House of Representatives passed a resolution inquiring the cost of removing obstructions between tide gauges No. 1 and No. 2, so as "to afford the same depth of water above station No. 1 as now prevails below it." In reply to this resolution a report was submitted April 3, 1872 (see Annual Report of the Chief of Engineers for 1872, page 814), containing the following estimates:

Basin, purchase of site, 18 acres, at $150	$2,700
Excavation to level of mean low water, 200,000 cubic yards, at 40 cents	80,000
Excavation of cut, 60,000 cubic yards, at 40 cents	24,000
Diking and revetting banks of cut	12,000
Engineering and contingencies	17,805
Total	136,505

This plan contemplated (as appears from maps on file) straightening the channel at Lockwood's, and as it was necessary in any case to replace the old arch bridge of the Boston road by a draw-bridge, to change the location of such bridge to a point about 700 feet eastward, so as to give a straighter and cheaper channel for the stream.

In 1873 $25,000 was appropriated for improving East Chester Creek.

It was designed to expend it in accordance with the above estimates, which were then considered an adopted project, but no means had been provided for acquiring the land needed for the proposed cut at Lockwood's, so no work was done at that time.

In 1875 it became apparent that the proposed change of location of the draw-bridge at Lockwood's could not be made. The old bridge lay on the boundary between the towns of East Chester and Pelham, and was supported by the towns jointly. Under the proposed change of location the new bridge would lie within the town of Pelham, which town would then have to support it; therefore the town of Pelham would not consent to the change, and the old bridge was replaced by an iron draw-bridge in the same location. The proposed location of the cut had, therefore, to be altered, to bring it to the draw-bridge. This necessitated excavating a considerable amount of rock at an increase of cost of $10,000. (See General Newton's letter to the Chief of Engineers, September 24, 1875.)

In 1875, $12,000 more was appropriated for this improvement, but it was not until 1877 that a commission, appointed by the State of New York, finally obtained the land for the proposed cut. After this right of way was secured, in 1877, a contract was entered into for making a cut 9 feet deep at mean high water (2 feet at low water), with a width of 100 feet at high water level; this contract included about 3,149 cubic yards of rock excavation, 1,210 linear feet of pile dike, and 140 linear feet of crib dike. It was completed in 1878, and in that year and 1879, under an appropriation of $10,000, made June 18, 1878, dredging was done by hired labor, removing a shoal of bowlders just outside of Pelham Bridge, and making a channel about 125 feet wide and 9 feet deep at high water on the west side of Goose Island, being an extension of the original project.

In 1879, $3,500 was appropriated for continuing the improvement, and $3,500 more in 1880; these appropriations were not expended until 1884.

In the Annual Report for 1879 it was stated, as necessary to complete the improvement from Pelham Bridge to Lockwood's, "to construct dikes from the lower end of the cut to Goose Island, a distance of 5,800 feet." In 1880, these dikes were estimated to cost $40,000.

The appropriations made were not large enough to warrant beginning the cut above Lockwood's, or the above-mentioned dikes, and these proposed works were apparently abandoned for the time being In 1881 General Newton, U. S. Engineers, then in charge, reported that, "furthermore, until it is proved that a depth of 9 or 10 feet * * * can not be maintained under the scale of improvement already completed, it will be unnecessary to inaugurate new works. The amount of funds available, $7,372.14, will be quite sufficient for the present wants of the case."

This money was expended in 1884 in dredging just below Town Dock, a work not included in the original estimate.

August 5, 1886, $10,000 were appropriated for this improvement, which was mostly expended in 1888 and 1889, in dredging between Town Dock and Lockwood's to remove shoals from the previously dredged channel.

In 1887, an estimate was made of the cost of the several proposed extensions of project, from which it appears that $84,600 have been either expended or estimated for works not included in the first estimate, and that estimate therefore should be increased to $221,000, if it is proposed to carry out the original plan with these extensions.

It was proposed to expend the appropriation of $5,000, made August 11, 1888, in dredging a cut above Lockwood's, and in January, 1889, the line of cut was staked out, and a description given to the State commissioners for securing right of way. They were asked to obtain permission to deposit the material on the marsh lands adjacent to the cut, which could be done cheaply as compared with the cost of carrying it out into Long Island Sound. The commissioners reported that this consent could not be obtained, and as the available funds were not sufficient to begin work under any other plan for disposing of dredged materials, work was postponed until larger appropriations should be made.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1890.

It was found impracticable to arrange for disposing of dredged materials economically, therefore no work was done.

PRESENT CONDITION OF IMPROVEMENT.

There is a channel not less than 9 feet deep at mean high water (2 feet at low water) from the bay up to Lockwood's, being about 100 feet wide to a point 1,000 feet above Town Dock, thence to Lockwood's, from 50 to 75 feet wide. The dikes on the east side of the channel below Lockwood's are in fair condition.

The cut above Lockwood's has not been begun.

PROPOSED OPERATIONS.

The proposed dikes below Town Dock do not seem to be necessary at present as a means of improving or maintaining the channel, and possibly they may be altogether dispensed with.

The completion of the project requires the excavation of a channel 100 feet wide and 9 feet deep at mean high water, up to tide gauge No. 1, a distance of about 3,000 feet through marsh lands, and not closely following the windings of the stream. The cost of towing dredged materials from this locality to the authorized dumping-ground is so great that very little can be accomplished with the available funds, unless arrangements can be made to deposit the material to be excavated upon the banks. It has been impossible so far to obtain the consent of the property owners to this. Unless this is done, and larger appropriations for the improvement are made than have been heretofore, it will be useless to continue it. At least $25,000 should be available, to commence this part of the work advantageously and economically.

Unless it is considered advisable to extend the improvement above Lockwood's no additional funds are needed. There is at present no navigation above this point, and it is problematical whether there will be to any great extent should the proposed improvement be made.

Appropriations for improving East Chester Creek have been made as follows:

Application.	Date.	Amount.
Cutting through marsh and rock, and diking (in 1877)	Mar. 3, 1873	$25,000
Dredging under Boston Road Bridge and at Goose Island	Mar. 3, 1875	12,000
Dredging near Lockwood's, Goose Island, and Pelham Bridge	June 18, 1878	10,000
Dredging 40 to 90 feet wide from Pell Point to Town Dock	Mar. 3, 1879	3,500
	June 14, 1880	3,500
Dredging above Town Dock (not wholly expended)	Aug. 5, 1886	10,000
Not yet expended	Aug. 11, 1888	5,000
Total		[illegible]

East Chester Creek is in the collection district of New York.

The nearest light-house is on the "Stepping Stones," 3 miles southeast of the mouth of the creek. The nearest work of defense is Fort Schuyler, Throg's Neck, about 3½ miles south.

Money statement.

July 1, 1889, amount available	$7,163.08
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	22.05
July 1, 1890, balance available	7,141.03
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	152,100.00

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1889.

Vessels arriving and departing.

Schooners	6
Sloops	5
Barges, scows, and canal-boats	62
Vessels, kind not stated	15
Total	88

Freights received (estimated).

Coal	tons	5,145
Lumber and building materials	do	5,200
Ice	do	300
Total		10,645

No statistics for 1888 were received. The above figures show a decrease from the estimates reported for the calendar year of 1886 of 5,465 tons.

No new lines of transportation have been established at East Chester Creek since July 1, 1889.

D 18.

IMPROVEMENT OF GREENPORT HARBOR, NEW YORK.

This harbor is a roadstead near the east end of the north fork of Long Island, lying between the north fork on the northwest and north and Shelter Island on the southeast and south. The anchorage ground is exposed to storms from the northeast and east.

A sand-spit, called Joshua's Point, formerly protected the little bay at Greenport from easterly storms, but in the few years prior to 1883 this had worn away rapidly, and the sand had been carried into the bay.

The mean rise of tide is 2.4 feet.

PROJECT FOR IMPROVEMENT.

In 1881 a survey was made, and, with the report, a plan and estimates based upon the survey were submitted and subsequently adopted for a breakwater extending southeasterly from Joshua's Point. This project consisted of a riprap breakwater about 1,700 feet long, extending from high-water mark to the 18-foot curve, to be built 3 feet above mean high-

water level, with a top width of 5 feet and side slopes of 1 on 1, to contain about 23,000 tons of stone. Its estimated cost was $46,000.

Work under this project was begun in 1883, and up to July 1, 1889, 17,185 tons of riprap had been placed in the breakwater, making its total length 1,535 feet.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1890.

At the beginning of the year work was in progress under a contract dated January 19, 1889, with William H. Molthrop & Co., of Gale's Ferry, Conn., for delivering riprap and extending the breakwater, at the rate of $1.23 per gross ton of riprap. The contract was completed July 10, 1889. During the month of July 1,011 tons of riprap were delivered, and the breakwater was extended 35 linear feet. The total amount of riprap delivered under this contract was 3,421 tons and the total length of breakwater built was 133 feet.

PRESENT CONDITION OF IMPROVEMENT.

The breakwater is now 1,570 feet long and contains 18,196 tons of riprap; it is in fair condition. No material changes of depth in the harbor have occurred since the survey of 1881.

PROPOSED OPERATIONS.

With future appropriations the breakwater will be completed as projected to the 18-foot curve. Thirty thousand dollars have been appropriated for this work; the remainder of the estimate, $16,000, could be profitably expended in one year in completing the breakwater.

Appropriations for improving Greenport Harbor have been made as follows:

Application.	Date.	Amount.
Survey	Mar. 3, 1881	$500
Expended on breakwater	Aug. 2, 1882	10,000
Do	July 5, 1884	10,000
Do	Aug. 5, 1886	5,000
Do	Aug. 11, 1888	5,000
Total		30,500

Greenport is a port of delivery in the collection district of Sag Harbor. The nearest light-house is on Long Beach Point, 3 miles to the eastward. The nearest work of defense is Fort Trumbull, New London Harbor, Connecticut, 21 miles distant in a straight line.

Money statement.

July 1, 1889, amount available	$131.23
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	131.23
Amount appropriated by act of September 19, 1890	5,000.00
Amount (estimated) required for completion of existing project	11,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892.	11,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of contract for improving Greenport Harbor, New York, in force during the fiscal year ending June 30, 1890.

Contractor.	Date of contract.	Subject of contract.	Price per ton.	Remarks.
Wm. H. Molthrop & Co., Gale's Ferry, Conn.	Jan. 19, 1889	Delivering riprap granite and construction of breakwater.	$1.23	Contract completed July 10, 1889.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1889.

Arrivals and departures of vessels.

Steamers		2,000
Sailing vessels		630
Barges, etc		20
Freight carried by above vessels (estimated)	tons	20,700
Draught	feet	6 to 12
Tonnage	tons	50 to 500
Number of vessels entering harbor for refuge (estimated)		100

The above statement shows a decrease in the amount of freight carried since 1886 (the last statement received) of 22,870 tons. It is believed that this does not represent so much actual decrease; the difference is probably chiefly due to errors in the data, which, however, are the best obtainable. No new lines of transportation were established at this harbor during the past year.

D 19.

IMPROVEMENT OF GLEN COVE HARBOR, NEW YORK.

Glen Cove Harbor is a small estuary, or creek, opening into the east side of Hempstead Bay, Long Island, about 1¾ miles from Long Island Sound and about 25 miles by water from the Battery, New York City. The channel in the creek is about 2 feet deep at mean low water, and a bar at the entrance has a foot less depth. Vessels entering Glen Cove Harbor have to wait for high tide, anchoring in Hempstead Bay, where they are exposed to storms from the north and northwest. When such storms are heavy it is impossible to tow over the bar, and from this cause vessels have been obliged to remain in the bay for three or four days exposed to heavy seas.

The mean rise of tide in this harbor is 7.7 feet.

PROJECT FOR IMPROVEMENT.

The act of Congress approved August 5, 1886, provided for a survey or examination of Glen Cove Harbor. A preliminary examination was all that was deemed necessary, and upon this, with assistance of United States Coast Survey charts recently published, a report with estimates of cost of improvement was presented, dated December 7, 1886, and printed in the annual report of the Chief of Engineers for 1887, Part I, page 645.

The plan of improvement described in this report contemplated a breakwater about 2,500 feet long, and extending in a general westerly direction from Mosquito Point, on the east side of Hempstead Bay, and north of the entrance to Glen Cove Inlet; the breakwater to be built

of riprap, the top to be 5 feet wide and 3 feet above high water, with side slopes of 1 upon 1, at an estimated cost as follows:

136,000 tons of riprap, at $1.35 per ton	$183,600
Contingencies, 10 per cent	18,360
Total	201,960

This project was adopted in 1888, an appropriation being made by Congress for beginning the work, and the location of the shore end of the breakwater was definitely fixed, to be at the northwest corner of the Glen Cove Dock, and its course to be west-southwesterly towards Mott's Point.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1890.

The contract which was in progress at the beginning of the fiscal year was completed January 29, 1890; 8,284 tons of riprap were delivered and 350 linear feet of breakwater were built, making the totals under the contract 12,500 tons riprap and 570 linear feet of breakwater.

By authority of the Chief of Engineers, after the completion of the contract, stone was purchased in open market at the price of contract work, and the breakwater was further extended 195 feet, 7,336 tons of stone being purchased. This work began January 29, 1890, and terminated May 6, 1890, when the available funds were exhausted.

In order to build a greater length of breakwater with the money available, and so to secure some effective shelter at once, the work was not built up to its full dimensions; it was made only 3 feet wide on top and 1 foot above high water. It may ultimately require enlarging to the dimensions given in the project.

PRESENT CONDITION OF IMPROVEMENT.

The breakwater is now 765 feet long and 3 feet wide on top, rising to 1 foot above high water; it contains 19,836 tons of riprap. It is in good condition.

PROPOSED OPERATIONS.

With future appropriations it is proposed to extend the breakwater and to enlarge it to the cross-section provided for in the project, if necessary. Fifty thousand dollars can be profitably expended for this purpose during the next fiscal year.

The only appropriation for improving Glen Cove Harbor is the one of $20,000, made August 11, 1888, and expended as above described.

Glen Cove Harbor is in the collection district of New York. The nearest lighthouse is on Sand's Point, about 4 miles west. Fort Schuyler, New York Harbor, is the nearest work of defense.

Money statement.

July 1, 1889, amount available	$8,118.14
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	8,008.52
July 1, 1890, balance available	109.62
Amount appropriated by act of September 19, 1890	15,000.00
Amount available for fiscal year ending June 30, 1891	15,109.62
Amount (estimated) required for completion of existing project	166,960.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	50,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of contract for improving Glen Cove Harbor, New York, in force during the fiscal year ending June 30, 1890.

Name and address of contractors.	Date of contract.	Subject of contract.	Price per ton for riprap.	Remarks.
Brown & Fleming, New York City.	Mar. 30, 1889	Delivery of riprap and construction of breakwater.	$0.83	Contract completed Jan. 29, 1890.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1889.

Arrivals and departures of vessels.

[Draught from 4½ to 7½ feet. Tonnage from 48 to 330 tons.]

	Number.	Registered tonnage.
Steamers	755	249,905
Sailing vessels	1,263	89,673
Barges, etc.	239	33,699
Total	2,257	373,277

Cargoes.

	Tons.	Value.
Freight received	158,151	$2,227,021
Freight shipped	143,278	3,798,548
Total	301,429	6,025,569

In the columns of arrivals and departures and of registered tonnage no account is taken of steam-tugs entering or leaving the harbor, or of steam-yachts or fishing vessels.

These figures show an increase over freights carried in 1888 of 13,564 tons; they are obtained from records and are believed to be correct.

No new lines of transportation were established in this harbor during the past year.

D 20.

IMPROVEMENT OF FLUSHING BAY, NEW YORK.

Flushing Bay is on the north shore of Long Island, about 14, miles by water from the Battery, New York City. The town of Flushing is on the east bank of Flushing Creek, just above the head of the bay. The bay is about 1 mile wide, and 2 miles long; the bottom is of soft mud, nearly level, the depth in the original channel being not much greater than elsewhere. In 1861 a depth of 5 feet at low water was reported in the channel leading up to Flushing; at the beginning of the improvement by the United States, the depth there was but 3.9 feet.

The mean rise of tide is 7.1 feet.

PROJECT FOR IMPROVEMENT.

A survey of Flushing Bay was made in 1878, and a project for improvement based upon the survey was proposed and adopted. This

project provided for constructing two dikes; the first to extend northerly from near the head (or south end) of the bay along the west side of the channel, then bending, to continue westward to Herrick's Point at the west side of the mouth of the bay, thus forming a large tidal basin which should fill and discharge through the main channel; the second, to start from a point near the middle of the east shore and extend northwardly to the 6-foot curve, confining the channel; it also provided for dredging to make and maintain a channel 6 feet deep at mean low water. The estimated cost of this work was as follows:

Constructing 4,400 linear feet of pile-dike, at $10 per foot	$44,000
Constructing 7,800 linear feet of pile-dike, at $9 per foot	70,200
Constructing 900 linear feet of pile-dike, at $7.50 per foot	6,750
Constructing 3,600 linear feet of single piling, at $3.70 per foot	13,320
For 83,000 cubic yards of dredging, at 20 cents per cubic yard	16,600
Contingencies	22,630
Total	173,500

All the timber work of the dikes was to be creosoted.

The first appropriation was expended in building 3,057 linear feet of pile-dike on the west side of the channel, extending northward from near the head of the bay. Subsequent appropriations until 1888 were expended in dredging to make and maintain the required channel depth, it being found necessary to dredge repeatedly in the same places; the total amount of material dredged in this period was about 235,000 cubic yards.

In September, 1888, a modification of the original project was approved, which provided for "extending the dike northward and towards the west side of the channel at College Point, and for dredging, omitting the dikes running westerly to Herrick's Point, and the single row of piles on the east side."

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1890.

The dike has been extended 1,606 linear feet, and partly filled with stone; 15,063 cubic yards have been dredged from the channel, restoring its width of about 100 feet and depth of 6 feet at mean low water.

PRESENT CONDITION OF IMPROVEMENT.

The part of the dike built in 1880 to high-water level has settled from a few inches to a foot; the part bulit in 1889 to 1 foot above high-water level is not yet completely filled with stone.

The channel in the bay, which has been dredged several successive times, has now the required depth of 6 feet at mean low water with rather less than 100 feet width.

PROPOSED OPERATIONS.

With future appropriations it is proposed to strengthen the dike by additional stone filling and by repairing the older part of the work, to extend the dike and to dredge to maintain the required depth in the channel.

Appropriations for improving Flushing Bay have been made as follows:

Application.	Date.	Amount.
Construction of dike	Mar. 3, 1879	$20,000
Dredging	June 14, 1880	15,000
Do	Mar. 3, 1881	10,000
Do	Aug. 2, 1882	5,000
Do	July 5, 1884	10,000
Do	Aug. 5, 1886	10,000
Construction of dike and dredging	Aug. 11, 1888	15,000
Total		85,000

Flushing Bay is in the collection district of New York. The nearest light-house is on North Brother Island, about 3 miles to the northwest. The nearest fortification is Fort Schuyler, about 4 miles to the northeast.

Money statement.

July 1, 1889, amount available	$5,739.77
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	3,596.36
July 1, 1890, balance available	2,143.41
Amount appropriated by act of September 19, 1890	20,000.00
Amount available for fiscal year ending June 30, 1891	22,145.41
Amount (estimated) required for completion of existing project	68,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	35,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of contract for improving Flushing Bay, New York, in force during the fiscal year ending June 30, 1890.

Name and address of contractors.	Date of contract.	Subject of contract.	Prices.
Henry DuBois's Sons, New York City.	June 4, 1889	Dike construction and dredging.	Piles driven per linear foot, 11 cents; yellow pine per M feet, $30; oak wale per M feet, $50; screw-bolts per pound, 4½ cents; drift-bolts per pound, 4 cents; spikes per pound, 4 cents; dredging per cubic yard, 20 cents.

Contract completed October 1, 1889.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1889.

Statistics for 1889 have been promised, but have not been received as yet. The amount of commerce for 1889 is probably not very different from that of 1888, when estimates were submitted as follows:

Arrivals and departures of vessels.

[Draught, 5 to 9 feet; tonnage, 20 to 300 tons.]

Kind.	Number.	Tonnage.
Steamers	830	115,000
Sailing vessels	878	43,200
Barges, etc	732	182,600
Total	2,440	341,400

Cargoes.

	Tons.	Value.
Shipments	135,475	$3,152,400
Receipts	93,760	2,502,425
Total	229,235	5,654,825

The principal articles of commerce are manufactured goods, coal, grain, building materials, and general merchandise.

D 21.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

WRECK IN HEMPSTEAD BAY, LONG ISLAND, NEW YORK.

ENGINEER OFFICE, U. S. ARMY,
New York, December 10, 1889.

GENERAL: I have the honor to submit the following report upon the removal of wreck of steamer *Bay Ridge*, sunk in Hempstead Bay, New York.

The *Bay Ridge* was a passenger steamer plying between New York City and points in Hempstead Bay, New York; she was 205 feet long, 32 feet beam, 9 feet depth, was built in 1882, and was owned by Louis Berndt, since deceased.

About midnight, August 10–11, 1888, the boat caught fire while at her dock at Glenwood, in Hempstead Bay; her mooring lines burned and she drifted out with the tide and sank in about 18 feet of water in the channel on the west side of the bay, where the bottom was very soft.

The first official notification of this wreck was contained in a letter dated September 7, 1888, addressed to Hon. Daniel Magone, collector of the port of New York, by John Hicks and others, of Roslyn, N. Y. This letter was referred to me for report. Upon communicating with the owner of the boat, I learned that he was taking steps to have her removed and I delayed my report until I could ascertain what the owner had done.

On January 29, 1889, I reported that the owner had completed his work, and that I was informed that no part of the wreck projected more than 2 feet above the surrounding bottom, and that the portions remaining would probably not be dangerous to navigation.

In April, 1889, it was reported that tug-boats had struck the wreck, and an investigation made by the inspector of the Third Light House District showed that some parts of the wreck were not more than 7½ feet below low water—that is, 10 feet above the bottom—and a buoy was placed over it. On the 12th of April I reported these facts to the Chief of Engineers, and in compliance with orders I subsequently submitted an estimate that the cost of removing the remainder of the wreck would not exceed $2,500; May 18, an allotment of $2,500 was made for this purpose.

The required notice to owners or parties interested in the wreck was published under date of June 5, 1889, and August 2, 1889, advertisement was made for proposals for removal.

Following is an abstract of the proposals received:

No.	Names of bidders.	Amount.	Remarks.
1	Charles W. Johnson and Franklin C. Maull, Lewes, Del	$1,095	Lowest bid.
2	Edward S. Lowe, New York City	2,750	Blasting.
3	R. G. Packard, New York City	1,750	
4	William C. Chapman, New York City	1,474	Not blasting unless necessary.

With approval of the Chief of Engineers, a contract dated October 1, 1889, was entered into with Messrs. Johnston and Maull, of Lewes, Del., for complete removal of the wreck to the level of the surrounding bottom for the sum of $1,095.

Before work was begun a careful examination of the spot was made, which showed that there were several apparently detached or separate pieces of the wreck left, the least depth found being 8.4 feet below mean low water.

The contractors began work October 16; their appliances consisted of a sloop, fitted out with appliances for diving and for blasting. About 400 pounds of Atlas powder were used, made up into half-pound cartridges, and placed in the wreck by a diver.

All of the wreck that could be found was shattered in this way, and on October 20 the contractors reported that nothing remained. An examination was made October 22, which showed that there were still several points to be removed. After working for a few days longer, the contractors reported that these had been taken out, but a second examination, made October 30, showed that the work was not yet completed. The sloop had been taken away and November 26 a wrecking schooner was sent there and five pieces of timber, with knees and bolts attached, were taken out, as well as several smaller pieces of planking. An examination was made November 30, by dragging a weighted line repeatedly over the bottom. One piece was found which was large enough or projected far enough to hold the line. This piece was removed and with some other pieces deposited on the flats on the east side of the harbor near the shore, entirely out of the channel. The greater portion of the wreck floated away in small pieces.

An examination has been made by order of the light-house inspector, who reports that there is 19 feet at mean low water on the site of the wreck; the buoy has been removed. (See copy of letter from Lieut. William C. Babcock, U. S. Navy, herewith.)

In addition to the sum of $1,095 paid the contractors, there has been expended $102.35 for advertising. No additional funds are needed.

Very respectfully, your obedient servant,

D. C. HOUSTON,
Colonel of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

LETTER FROM THE ASSISTANT INSPECTOR OF THE THIRD LIGHT-HOUSE DISTRICT.

U. S. GENERAL LIGHT-HOUSE DEPOT,
OFFICE OF THE U. S. LIGHT-HOUSE INSPECTOR, THIRD DISTRICT,
Tompkinsville, N. Y., December 9, 1889.

SIR: I have to inform you that, in obedience to the order of Commander Rodgers, I made an examination of Hempstead Harbor on the 8th of December, and found no

trace of the wreck of the steamer *Bay Ridge*, there being 19 feet mean low water where it formerly was. The wreck buoy was accordingly removed.

By direction of the inspector.

Respectfully yours,

WM. C. BABCOCK,
Lieut. U. S. N., Assistant Inspector.

Col. D. C. HOUSTON,
Corps of Engineers, U. S. A.

D 22.

PRELIMINARY EXAMINATION OF BROWN'S CREEK, SAYVILLE, NEW YORK.

ENGINEER OFFICE, U. S. ARMY,
New York, October 27, 1888.

SIR: I have the honor to submit the following report on a preliminary examination of Brown's Creek, Sayville, N. Y., made in pursuance of the river and harbor act of August 11, 1888, and directed by letter of the Chief of Engineers, dated August 28, 1888.

Lieut. James C. Sanford, Corps of Engineers, who recently visited the locality, makes the following report dated October 16, 1888:

Brown's Creek is a small stream flowing almost midway between the villages of Sayville and Bayport, near the south shore of Long Island, and emptying into Great South Bay, 11½ miles east northeast of Fire Island Inlet. The mouth is about 20 feet wide at mean low water, and is obstructed by a sand-bar, which at unusually low water entirely closes the mouth, and at mean low water has a depth over it of only 2 or 3 inches. Inside the mouth the creek is deeper and wider. The average depth from the mouth to the bridge between Sayville and Bayport (a distance of 5,300 feet by the course of the stream and about 4,500 feet in a straight line) is about 20 inches at mean low water. The mean rise of tide is about 1.1 feet. At about 350 feet from its mouth the stream turns abruptly to the east, and runs in that direction for 150 feet thence south to the bay. For this 150 feet a sand-spit, rising about 1 foot above mean high water, separates the creek from the bay. The end of this spit is rapidly advancing eastward, owing to the drift of sand from the west in southwesterly winds, and is shifting the mouth of the creek to the east. The sand-bar at the mouth of the creek is the extension of this spit under water to the east and southeast. An examination of the bar shows it to be composed of very soft sand, evidently carried there by storms, while the bottom along the beach to the westward is of hard sand and pebbles. The shifting of sand by currents in Great South Bay is regularly, it is said, from west to east. Except near and opposite the mouth of the creek the beach slopes rather steeply outward to the 4-foot curve in the bay.

The effect of the tide is almost imperceptible at the bridge, and from this point up the water of the creek is said to be fresh, being supplied by numerous springs. The current at and near the mouth was, at the time of my visit, very slight, but it is said to be often considerably stronger. It is mainly due to the fresh water from above. The bed and banks of the stream are mostly of sand, as is nearly all that part of Long Island. The mouth of the creek is three-quarters of a mile from Sayville (to which a level road leads) and one-half mile from Bayport.

PRESENT COMMERCE.

Sayville is said to have a permanent population of 3,500 (I should estimate it at less), and a summer population of 4,500, and Bayport a permanent population of 1,500, with an increase of 300 in summer, and both towns are growing quite rapidly. The permanent population of these towns depends almost entirely, either directly or indirectly, upon the oystering and fishing industry, there being no manufactures and almost no farms in or near either place. I was informed that about 325 oyster and fishing boats, belonging to Sayville and Bayport were registered at the custom-house in Patchogue, with a total tonnage of 2,950 tons. This is exclusive of all boats under 5 tons, of which there are said to be about 150. The boats draw from 20 inches to 3 feet, and are principally sloops. The oyster and fishing fleet during the summer have to lie at anchor in the open bay. In storms they are frequently washed ashore, as many as ten having been washed ashore in a single night. In the

winter they are mostly laid up at Patchogue, 4 miles east, and in the Connequot River, 3½ miles west, as they can enter and leave Brown's Creek only on extraordinary high tides. When ice is expected to form in the bay the boats are taken at once to their winter quarters to avoid being caught in the bay by ice. If the ice does not form as soon as expected the boats would be used in the day-time, being taken each night to Patchogue or the Connequot River, were it not for the distance to be traveled each morning and night from Sayville. If there were a harbor at Sayville, where these boats could be laid up, it is estimated that a month each year could be saved to the oystermen and fishermen.

About 5,000 tons of coal, building materials, and general merchandise are annually brought into these two towns, but at present the larger part of it comes by rail; about 700 tons of coal and some building materials, however, are annually brought by water, but on account of the difficulty of unloading the proportion brought by water is constantly diminishing. It is said to be impracticable to build docks extending into the open bay strong enough to withstand the ice and storms. Last winter the ice on the bay between Sayville and Fire Island Beach, which separates the bay from the ocean, was 22 inches thick, and every winter the bay is frozen completely across. Fire Island Beach is too low to break the winds from the ocean, and ice is often driven through and across the bay with great force. Vessels wishing to unload come up toward the beach until they ground, and wagons are driven out to them through the water to take the cargoes ashore. Of course, only sloops and schooners of light draught can be used in this way. The vessels so used carry from 12 to 40 tons, and seldom draw over 4 feet. The difficulty of landing cargoes makes the water transportation unusually expensive, and enables the Long Island Railroad to maintain excessive freight rates to these places.

PROSPECTIVE COMMERCE.

If the entrance to the creek were deepened so as to allow vessels of 6 feet draught to enter and unload at docks just inside the entrance, it is claimed that all the coal and building materials and much of the general merchandise used in Sayville and Bayport would be brought by water. With the reduction in the price of building materials thus caused it is thought that a large number of country houses would be put up in this vicinity by persons who are at present deterred by high cost of transportation of these materials.

DESIRED IMPROVEMENT.

It is desired to have a channel 100 feet wide and 6 feet deep at mean low water cut from the 6-foot curve in the bay, across the sand-spit, to the point where the creek near its mouth bends toward the east; to widen the creek to 100 feet and deepen it to 6 feet from this point to the next bend of the creek going north; to protect the dredged channel in the bay by a breakwater or jetty on its west side; and to excavate a basin next north of the dredged channel, 4 feet deep and of sufficient size for laying up one hundred and sixty-seven oyster and fishing boats, the present number that would use such a harbor.

I have estimated for a basin of 4 acres, which gives sufficient room for laying up two hundred of these boats. To dredge a channel 100 feet wide and 6 feet deep from the 6-foot curve in the bay, including the cut through the beach and widening the creek, about 1,900 feet in all, would require the removal of 33,000 cubic yards of sand, measured in scows, which at 30 cents per cubic yard would cost $9,900.

To construct a jetty 1,650 feet long, 3 feet wide on top, with side slopes of one on one, and rising 1 foot above high water, would require 4,700 tons of stone, which at $2.50 per ton would cost $11,750.

To excavate a basin of 4 acres, 4 feet deep at mean low water, would require the removal of 52,000 cubic yards of sand, which at 30 cents per cubic yard would cost $15,600.

Adding $5,750 for engineering and contingencies (about 15 per cent), gives a total of $43,000. * * *

It will be seen that any improvement made in this locality must be almost entirely artificial, as the creek is of very little use as a harbor. The accompanying tracing from the Coast Survey chart of the southern coast of Long Island shows the locality, with the Patchogue River 4 miles east, and the Connequot River 3½ miles west, where boats are laid up for the winter.

In 1886 an examination was made of Patchogue River in pursuance of the river and harbor act of August 5, 1886, yet no appropriation was

made at the session of Congress, though it was reported worthy of improvement.

The cost of making a harbor at Brown's Creek is estimated at $43,000.

I do not think that this expenditure is warranted by the present and prospective demands of commerce, especially in view of the proximity of the Patchogue and Connequot rivers, and I would therefore report that, in my opinion, Brown's Creek is not worthy of improvement.

Very respectfully, your obedient servant,

D. C. HOUSTON,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

LETTER OF MR. JOSEPH WOOD.

PETTIT & WOOD, ATTORNEYS AND COUNSELLORS AT LAW,
New York, February 23, 1889.

DEAR SIR: I have the honor to present to you herewith a petition for the further inspection and survey of Brown's River, with a view to its recommendation to Congress for improvement as a harbor, very generally signed by the substantial men of the vicinity. In addition it is my privilege to inclose a letter from Hon. James W. Covert, Congressman-elect, from the Long Island district, indorsing the petition. As a citizen of the neighborhood of Brown's River, without other interest in the matter than the public advantage, the improvement has my heartiest well-wishes.

May I ask you to advise me of any action your department may be pleased to take in this matter, in order that we may be prepared to present to the officer in charge such surveys and statistics as will aid his determination?

Very respectfully yours,

JOSEPH WOOD.

The CHIEF OF ENGINEERS.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
March 7, 1889.

Respectfully referred to Lieut. Col. D. C. Houston, Corps of Engineers, for his views regarding the reconsideration of this matter, as desired by the petitioners.

These papers to be returned to this office.

By command of Brigadier-General Casey:

JAS. C. POST,
Major of Engineers.

[Second indorsement.]

ENGINEER OFFICE,
U. S. ARMY,
New York, March 8, 1889.

Respectfully returned to the Chief of Engineers. My report on preliminary examination of Brown's Creek, Sayville, N. Y., dated October 27, 1888, was based on a personal examination by First Lieut. J. C. Sanford, Corps of Engineers, and consists principally of extracts from his report to me. He had interviews with several of the citizens, and particularly with Messrs. Morris J. Terry, William F. Hibbard, and H. Richmond, whose names are among those on this petition.

Every opportunity was given to furnish commercial statistics, and these were supplied by Messrs. Terry and Hibbard.

No survey can be made unless it shall appear from a preliminary examination that the harbor or river is worthy of improvement, having in view the present and prospective demands of commerce. My report contains, I think, all the information necessary to decide this question, unless, possibly, as to the amount of commerce to be benefited, which is claimed in the petition to be very large. At the same time it is proper that those interested should have every opportunity to express their views,

and I would therefore recommend that the preliminary examination be continued for the purpose of procuring additional information.

There are sufficient funds on hand for this purpose from the allotment for preliminary examinations in this district.

D. C. HOUSTON,
Lieut. Col. of Engineers.

[Third indorsement.]

OFFICE CHIEF OF ENGINEERS, U. S. ARMY,
March 13, 1889.

Respectfully returned to Lieutenant-Colonel Houston, whose recommendation in the preceding indorsement is approved, and who is authorized to apply therefor as much as may be necessary of the funds in his hands for preliminary examinations in his district.

* * * * * * *

By command of Brigadier-General Casey:

JAS. C. POST,
Major of Engineers.

SUPPLEMENTAL REPORT.

ENGINEER OFFICE, U. S. ARMY,
New York, May 18, 1889.

GENERAL: I have the honor to submit the following report on continuation of the preliminary examination of Brown's Creek, Sayville, N. Y., made in pursuance of the river and harbor act of August 11, 1888.

In my report dated October 27, 1888, I stated that "the cost of making a harbor at Brown's Creek is estimated at $43,000. I do not think that this expenditure is warranted by the present and prospective demands of commerce, especially in view of the proximity of the Patchogue and Connequot rivers, and I would therefore report that, in my opinion, Brown's Creek is not worthy of improvement."

The people interested were dissatisfied with this report, and upon their representations I was authorized to make a further examination.

I forward herewith a communication from the executive committee of the village improvement society, which fully states very clearly the need of a harbor at Sayville. It seems that the demands of commerce in that vicinity are much greater than appears from the information which could be obtained at the time when my former report was made. It is claimed that if a harbor were provided there it would enable the people engaged in the oyster and fishing industries to be employed some two months longer during the year than is now the case.

I have recently made a personal examination of Brown's Creek and vicinity, and am satisfied that a harbor there would be of great benefit to a very important industry. The number of persons employed as crews of the boats is stated to be about 500.

It is probable that a useful improvement can be made at less cost than the former estimate. For these reasons I would report that, in my opinion, Brown's Creek is worthy of improvement. A survey is necessary to prepare plan and estimates of cost. The expenses of the survey will not exceed in addition to the funds on hand $75, an estimate for which is submitted.

Very respectfully, your obedient servant,

D. C. HOUSTON,
Lieut. Col. of Engineers.

Brig. Gen THOMAS L. CASEY,
Chief of Engineers, U. S. A.

SURVEY OF BROWN'S CREEK, SAYVILLE, NEW YORK.

ENGINEER OFFICE, U. S. ARMY,
New York, November 26, 1889.

GENERAL: I have the honor to submit the following report on survey of Brown's Creek, Sayville, N. Y., made in pursuance of the river and harbor act of August 11, 1888.

Reports on preliminary examinations were submitted by me, dated October 27, 1888, and May 18, 1889.

Accompanying the last-mentioned report was a communication from the executive committee of the Village Improvement Society of Sayville, which gives very fully the reasons why a harbor is needed at that locality.

For information as to the benefit to commerce and navigation which would result from a harbor at Sayville, I would refer to this paper and also to the accompanying communication from the same committee, dated June 29, 1889. Such a harbor as is needed can be provided by the improvement of Brown's Creek, which is a small stream emptying into Great South Bay on its north shore, and is in about the center of the district inhabited by the oystermen and fishermen.

A survey of this creek was made by Mr. Henry N. Babcock, assistant engineer, in June, 1889, and the results are shown on the accompanying tracing.* The portion of the creek (5,000 feet in length) embraced in the survey has an average width of 77 feet, and a depth varying from 0 feet to 3 feet below mean low water in Great South Bay. The depth at the entrance is 0.4 foot.

The object of the desired improvement is to secure an anchorage-ground, or place where the fishing boats can lie in safety during rough weather. This can be accomplished by widening and deepening the creek and improving its mouth. To prevent the entrance from filling up by drift and wave action, jetties will probably be needed on both sides, certainly on the west side, as the drift of sand along the shore is from the west to east. The jetties should be of riprap, the top and slopes to be of stone weighing not less than one-fourth ton, the top to be 3 feet wide and 1 foot above high water, with slopes of one on one. The stone on the top and slopes should be selected and carefully laid so as to present as smooth a surface as possible, to resist the action of moving ice.

The cost of dredging a channel 100 feet wide and 6 feet deep at mean low water from the 6-foot curve in the bay up to the first bend in the creek (1,850 feet) is estimated to be—

33,000 cubic yards, at 30 cents per cubic yard, the material to be deposited in the bay	$9,900
For a 4-foot channel 100 feet wide above this point to the highway bridge, 4,680 feet, 86,000 cubic yards, at 14 cents per cubic yard, the material to be placed on the banks	12,040
Cost of west jetty, 1,600 feet long, 3,700 cubic yards of riprap, at $2.50 per cubic yard	9,250
Cost of east jetty, 1,400 feet long, 3,100 cubic yards of riprap, at $2.50 per cubic yard	7,750
Contingencies	7,060
Total	46,000

The first work to be done should be the deepening at and near the mouth, and the construction of jetties, commencing at the shore end. These works should be carried on simultaneously.

* Omitted: Printed in House Ex. Doc. No. 22, Fifty-first Congress, first session.

This improvement would not only benefit those engaged in oystering and fishing, but would enable many articles of commerce to be brought to Sayville by water instead of by rail, as at present. A partial improvement would be of great benefit to the small vessels.

Very respectfully, your obedient servant,

D. C. HOUSTON,
Colonel of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

LETTER FROM EXECUTIVE COMMITTEE OF THE VILLAGE IMPROVEMENT SOCIETY OF SAYVILLE, NEW YORK.

[In proposed improvement of Brown's River.]

SAYVILLE, LONG ISLAND, N. Y., *June* 29, 1889.

The executive committee of the Village Improvement Society beg leave to supplement their former address with the following statistics, which have been carefully compiled from the results of exhaustive inquiries, and are believed to be the most accurate representation obtainable. The committee are well assured that the figures given below are "inside" estimates in each instance, and are entirely free from exaggeration.

Annual product of the Great South Bay between Patchogue and Great Rivers; number of vessels and men employed and their earnings.

Products.	Quantities.	Values.
Good fish for market ..... tons	95	$11,875
Menhaden (estimated by number)	17,000,000	21,250
Mussels ..... bushels	65,000	2,600
Oysters ..... do	175,000	175,000
Clams, 7,650,000 (sold by count) ..... bushels small	3,000	18,000
Total		229,025

Vessels employed.	Number.	Earnings per annum.
Sloops, each $1,100	82	$90,200
Cat-boats, each $1,000	122	122,000
Schooners, each $2,000	9	18,000
Total		230,200

Men and boys employed, residing in the villages of Sayville, Bayport, and Blue Point.

Eighty-two sloops	246
One hundred and twenty-two cat-boats	366
Nine schooners	64
Total	676

Respectfully submitted.

JOSEPH WOOD,
Counsel to the Committee.

Col. D. C. HOUSTON,
Corps of Engineers, U. S. A.

D 23.

PRELIMINARY EXAMINATION OF LARCHMONT HARBOR, NEW YORK.

ENGINEER OFFICE, UNITED STATES ARMY,
New York, November 28, 1888.

SIR: I have the honor to submit the following report on a preliminary examination of Larchmont Harbor, New York, made in pursuance of the river and harbor act of August 11, 1888, and directed in letter from the Chief of Engineers, dated August 28, 1888.

The accompanying report of Lieut. James C. Sanford, Corps of Engineers, gives a detailed description of the harbor and other information.

This harbor is located on the north shore of Long Island Sound, about 20 miles from New York City. At the entrance to the harbor are two rocks which are dangerous to navigation. The cost of removing these rocks to a depth of 15 feet mean low water is estimated approximately as follows:

Removal of Umbrella Rock, 2,500 cubic yards, at $25	$62,500
Removal of Huron Rock, 225 cubic yards, at $25	5,625
Contingencies	9,875
Total	78,000

This harbor is principally used by vessels belonging to the Larchmont Yacht Club, one of the largest organizations of the kind in this country. In May, 1888, the yachts enrolled on the club's list included 25 steamers, with a total tonnage of 1,754 tons, the largest measuring 568 tons; 26 schooners, with a total tonnage of 1,491 tons; 70 sloops, with a total tonnage of 1,672 tons, and 55 smaller boats.

Since then from twenty to twenty-five new vessels have been added, ranging from 20 to 300 tons, making the total number about two hundred. The total value of these vessels is estimated at from $3,500,000 to $4,000,000. The harbor is also largely used by vessels belonging to other clubs, and to a small extent by commercial vessels.

In view of the value of the property to be benefited and the importance to the country of the yachting industry, I am of opinion that the harbor is worthy of improvement.

In the construction and navigation of yachts a large number of persons are employed, improvements in ship-building are encouraged, seamen are trained in their duties, and the naval power of the country is thus increased.

No general survey of the harbor is needed, as the Coast Survey charts are very complete, but a detailed survey of the rocks is necessary to ascertain the exact amount of material to be removed. For such a survey the sum of $600 is estimated.

Very respectfully, your obedient servant,

D. C. HOUSTON,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF LIEUTENANT JAMES C. SANFORD, CORPS OF ENGINEERS.

ENGINEER OFFICE, UNITED STATES ARMY,
New York, October 19, 1888.

SIR: In accordance with your instructions I made a preliminary examination of Larchmont Harbor, New York, on the 19th ultimo, and have the honor to make the following report:

DESCRIPTION OF HARBOR.

Larchmont Harbor, known on the Coast Survey chart of Long Island Sound as Delancey Cove, is a bay indenting the north shore of Long Island Sound about 6 miles west of the boundary line between the States of New York and Connecticut. It is nearly rectangular in shape, and is about five-eighths of a mile long (north and south) by a half mile wide (east and west). The headland on the west side of the entrance projects about one-fourth of a mile further to the south than that on the east side (Long Beach Point). The depth varies from 0 to 18 feet at mean low water, though the latter depth exists only at the mouth of the harbor. The area within the 12-foot curve is about 13 acres, and that within the 6-foot curve about 68 acres. The mouth of the harbor is obstructed by two rocks—Umbrella Rock, with a depth of 4 feet over it at mean low water and an area within the 15-foot curve of about 1,350 square yards, and Huron Rock (not shown on the chart), with 9 feet depth at mean low water and an area within the 15-foot curve of about 225 square yards. Umbrella Rock is about 800 feet from the west side of the entrance and Huron Rock about the same distance from the east side, both rocks being near the line joining the headlands. An extensive reef, with outlying shoal spots known as the Hen and Chickens, with its highest point 3 feet above mean low water and having an area within the 16-foot curve of about 75 acres, lies about 1,200 feet directly south of the mouth of the harbor, and prevents vessels from entering the harbor by a direct course. Umbrella Rock lies almost in the center of the channel by which vessels passing to the west of the Hen and Chickens enter the harbor, while Huron Rock occupies a similar position in the east channel. Several vessels have struck Umbrella Rock during the past season, one being considerably injured, and one vessel ran on Huron Rock (the existence of the rock was not known until this time) and could not be gotten off until the next high tide, sustaining severe injuries. On account of the danger of swinging against them, these rocks considerably reduce the anchorage room near the mouth of the harbor, where steamers and schooners of deep draught have to anchor. The harbor is often overcrowded, and the matter of anchorage room is an important one.

PRESENT COMMERCE.

Larchmont is a suburban village, having a population of about 2,000 in summer and 300 in winter, and is growing rapidly. It was founded and developed by a land association known as the Larchmont Manor Company. No business, except hotel keeping, is allowed to be carried on in the place, and the harbor is little used for commerce. The only cargoes brought into the harbor during the past year were, as far as I could learn, 4 schooner-loads of building materials. It is, however, largely used by the vessels belonging to the Larchmont Yacht Club, one of the largest and most rapidly growing organizations of this kind in the country. In May, 1888, the club had a membership of 504, and the yachts enrolled on the club's list included 25 steamers, total tonnage 1,754 tons; 26 schooners, total tonnage 1,491 tons; 70 sloops, total tonnage 1,672 tons; and 55 smaller boats, tonnage not given, making a total of 176 vessels with a total tonnage of 4,917 tons, exclusive of the 55 small boats. The club list issued in May, 1888, shows the condition of the club at that time. Since then the membership has been increased to 597, and from 20 to 25 new vessels, ranging from 20 to 300 tons, and having a larger average tonnage than the vessels on the May list, have been added. The total value of the vessels belonging to the club is estimated, from the known values of several of the vessels, at from $3,500,000 to $4,000,000.

A large number of the residents of Larchmont are members of the club and yacht-owners. Their yachts are usually anchored in the harbor during the summer season (May 1 to October 15). The other yachts belonging to the club use the harbor for a considerable part of the season. In addition, a great many yachts belonging to other clubs use the harbor. Their number is estimated at about one-half the number belonging to the Larchmont Club. At the time of my visit, September 19, there were 4 steam-yachts tonnage 260; 3 schooners, tonnage 142; 19 sloops, tonnage could not be obtained; 1 steam-launch, 2 naphtha-launches, and 6 cat-boats in the harbor, with a total value of $465,000. On September 1 (the day of the regatta), I counted in the harbor 5 steam-yachts, tonnage 592; 9 schooners, tonnage 421; 42 sloops, tonnage of 3,125; 2 tugs, 1 of 100 tons; 4 steam-launches, 1 of 9 feet draught; 3 naphtha-launches and about 20 cat-boats. The number given above for September 19 is only about half that using the harbor daily in July and August. On the night of July 3, 1887,

124 cabin boats (exclusive of smaller) anchored in the harbor in readiness for the regetta of July 4; and on July 3, 1888, the number was considerably greater. At such times (6 to 10 days each season) the harbor is greatly overcrowded.

The yachts using the harbor frequently have to enter it after dark, on account of being becalmed, or other reasons. The rocks at the bottom are then very dangerous. The rather light construction of the yachts increases this danger, and their comparatively great value renders the wreck of one of the more valuable ones a serious loss.

It is said that within the past season from 100 to 200 commercial vessels have used the harbor for refuge from winds from west to northeast. This is a decided increase over previous years, and is due to the harbor being better known and its obstructions more thoroughly buoyed.

PROSPECTIVE COMMERCE.

The increase in the club's membership and in the number of yachts belonging to it has been very rapid. This increase will probably continue. The proportional increase in tonnage has been still greater, and it is expected that most of the largest yachts on the North Atlantic coast will soon be on the club's list. The finest yacht club-house in the country, it is said, has been erected here during the past year, at a cost of over $100,000, and grounds covering several acres and having a large water front have been bought and finely improved by the club. These added attractions have largely increased the use of the harbor by yachts during the past season, and a continued increase may be looked for. A ship-yard and marine railway for the repair of yachts and other vessels is to be established on the west side of the harbor. It is thought that the harbor would be considerably used as a harbor of refuge by coasting vessels if the obstructions at its mouth were removed. The improvement of the harbor would increase its use by the large yachting fleet of Long Island Sound and New York Harbor, and would relieve the anchorage ground of commercial harbors, where the anchoring of yachts often seriously interferes with commerce. New Rochelle Harbor, City Island Roads, and parts of New York Bay are much obstructed in this way, and collisions often result from it.

DESIRED IMPROVEMENT.

The removal of Huron Rock to 15 feet at mean low water, and of Umbrella Rock preferably to 15 feet (though its removal to 12 feet would give substantial relief, as there were on the list of last May only six vessels belonging to the club drawing 12 feet or over) is desired.

To remove Huron Rock to 15 feet would require the removal approximately of 225 cubic yards of rock measured in place, which, at $25 per cubic yard, would cost $5,625.

To remove Umbrella Rock to 15 feet would require approximately the removal of 2,500 cubic yards of rock, which, at $25 per cubic yard, would cost $62,500.

Adding $9,875 (about 15 per cent) for engineering and contingencies, would make a total of $78,000.

If Umbrella Rock were removed to 12 feet the cost of its removal would be reduced about one-half, and the total cost of the improvement would be about $42,500.

The rock taken out can be deposited in the upper part of the harbor, where it is desired to form a breakwater.

Before a close estimate could be made, a careful survey would be necessary. I should estimate its cost at $600.

I am indebted to Messrs. G. C. W. Lowrey, E. L. Bushe, and others, of the Larchmont Yacht Club, for information and facilities for making the examination.

Very respectfully, your obedient servant,

JAMES C. SANFORD,
First Lieut. of Engineers.

Col. D. C. HOUSTON,
Corps of Engineers, U. S. A.

SURVEY OF LARCHMONT HARBOR, NEW YORK.

ENGINEER OFFICE, UNITED STATES ARMY,
New York, November 26, 1889.

GENERAL: I have the honor to submit the following report on survey of Larchmont Harbor, Long Island Sound, New York, made in pursuance of the river and harbor act of August 11, 1888.

I would refer to my preliminary report, dated November 28, 1888, for information as to the amount of commerce and navigation to be benefited by the improvement of this harbor. The entrance to the harbor is obstructed by two rocks, shown on the accompanying tracing, known as Umbrella and Huron rocks. When the preliminary examination was made it was understood to be the desire of those interested in the harbor to have these rocks removed, and a detailed survey was made in August–September, 1889, by Mr. Henry N. Babcock, assistant engineer, for the purpose of making an accurate estimate. I transmit his report, which includes a survey of other obstructions and an alternate project for breakwaters. This latter does not at present meet the approval of those interested, but is submitted for consideration.

The quantity of rock to be removed above the plane of 15 feet below mean low water is—for Umbrella Rock, 3,329 cubic yards; for Huron Rock, 336 cubic yards; total, 3,665 cubic yards. The estimated cost of removing this amount, including contingent expenses, is $126,600.

The rock removed should be deposited on the northerly end of Hen and Chickens Reef, in depth of 14 or 15 feet, to form a breakwater or beacon to clearly mark the location of the reef and the entrance to Larchmont Harbor.

Very respectfully, your obedient servant,

D. C. HOUSTON,
Colonel of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. HENRY N. BABCOCK, ASSISTANT ENGINEER.

ENGINEER OFFICE, UNITED STATES ARMY,
New York, November 21, 1889.

COLONEL: I have the honor to submit the following report upon a survey of Larchmont Harbor, New York, made under your direction in August–September, 1889:

GENERAL DESCRIPTION OF HARBOR AND STATEMENT OF PRESENT AND PROSPECTIVE COMMERCE.

These are given in sufficient detail and accuracy in your report on the preliminary examination of Larchmont Harbor (with Lieutenant Sanford's report as inclosure) dated November 28, 1888 (see Letters Sent—examinations and surveys, pages 204–210). The name of the harbor is changed from Delancy Cove to Larchmont Harbor on the last Coast Survey chart. No material changes have taken place in present or prospective commerce since the date of that report.

SURVEY AND MAP.

In your report upon the preliminary examination you stated that no general survey of the harbor was needed, as the Coast Survey chart was very complete, but a detailed survey of the rocks was necessary to ascertain the exact amount of material to be removed. However, part of the time the water was too rough to work on the rocks, and during that time a partial survey of the harbor was made in order to show the relation of the rocks to the channels and anchorage ground.

Umbrella Rock was surveyed by driving four stakes around it and stretching lines across, taking soundings at 5-foot intervals. One of these stakes was run down by a schooner soon after setting, and was replaced. After the work of sounding was nearly finished sea-weed collected on the lines to such an extent that they could not be stretched tight, and the rest of the rock was covered with soundings located by transits on shore.

Huron Rock was also surveyed by angles taken to each sounding, as the bottom there was too hard to drive stakes.

Besides, there are two ledges inside the harbor which were surveyed, as verbally

directed by you. Soundings on these ledges were also located by intersecting angles. I could not find any local name applied to these ledges, so have designated them on the map as North Ledge and South Ledge; each is marked by two spindles, one near the upper and one near the lower end.

Mean low-water plane was determined by leveling to connect the tide-gauge with the bench-mark at New Rochelle Harbor.

The general map* of the harbor is platted to a scale of 200 feet to the inch, and detailed maps* of the rocks on the same sheet to a scale of 20 feet to the inch.

DETAILED DESCRIPTION OF ROCKS.

Umbrella Rock is about 800 feet southeast from Umbrella Point, from which it is separated by a channel over 16 feet deep quite up to the shore, with bottom of soft mud. The rock is entirely surrounded by mud so soft that in places it is difficult to tell whether the sounding passes through mud or not before reaching the rock. Umbrella Rock has two summits, one with a least depth of 3.1 feet, the other with a least depth of 3.9 feet, and having a gap about 10 feet deep between them. The surface of the rock is quite ragged. The least bottom depth around the rock is 15 feet.

Following are the areas of contours 3 feet apart on this rock and the volume of rock in place above such contours:

	Area.	Volume above.
	Square yards.	*Cubic yards.*
6-foot contour	209	55
9-foot contour	800	550
12-foot contour	1,394	1,657
15-foot contour	1,997	3,329

Showing that the average depth of rock is above the 12-foot curve 3.6 feet, above the 15-foot curve, 5.0 feet.

Huron Rock is about 900 feet southwest from Flagler's Point, to which it is connected by a gradually sloping bottom with maximum depth of 15 feet, the bottom being hard sand with many outcroppings of rock, probably bowlders.

The channel between the rock and shore is safe only for light-draught vessels. Huron Rock is apparently a ledge, with least depth of 9.8 feet, while the least depth of the surrounding bottom is 15 feet.

Following are the areas of contours 3 feet apart, with the volumes of rock in place above each:

	Area.	Volume above.
	Square yards.	*Cubic yards.*
9-foot contour	0	0
12-foot contour	148	42
15-foot contour	495	336

Showing that the average depth of rock is above the 12-foot curve 1.2 feet, above the 15 foot curve, 2.0 feet.

North Ledge lies near the west side of the harbor, about 1,700 feet north of Umbrella Rock. It is separated from the west shore by a channel of 10 feet depth (except at the north end, where the depth is 9 feet), with a muddy bottom, but this channel is very little used. The rock is continuous, but has three crests rising above low-water mark, with elevations +0.7, +1.0, +2.4, and depths of 4 feet or over between. The rock is quite ragged and irregular.

Following are the areas of certain contours and volumes of rock in place above each:

	Area.	Volume above.
	Square yards.	*Cubic yards.*
Mean low-water contour	74	22
6-foot contour	1,304	1,080
9-foot contour	2,602	3,024

* Omitted; printed in House Ex. Doc. No. 40, Fifty-first Congress, first session.

Showing that the average depth of rock is above the 6-foot curve 2.5 feet, above the 9-foot curve, 3.5 feet.

South Ledge also lies near the west side of and near the mouth of the harbor; between it and the west shore there is a channel of 11 feet depth, with soft mud bottom, but the channel is out of the way and but little used. The rock is in two parts, separated by a channel 10 feet deep and about 25 feet wide. The north part rises to 4.1 feet above low water, and the south part to 1.0 foot above.

Following are the areas of certain contours for both parts of this ledge together, with volumes of rock in place above those contours:

	Area.	Volume above.
	Square yards.	*Cubic yards.*
Mean low-water contour	151	53
6-foot contour	791	859
9-foot contour	1,205	1,864
11-foot contour	1,553	2,773

Showing that the average depth of rock is above the 6-foot curve 3.2 feet; above the 9-foot curve, 4.6 feet; above the 11-foot curve, 5.3 feet.

DESIRED IMPROVEMENT.

At the time of the survey I spoke with several members of the Larchmont Yacht Club, who are the parties chiefly interested; what they wished was the removal of Umbrella and Huron rocks. They would also like to have the North Ledge removed, but did not think they would ask the United States to undertake that now. At some subsequent time they said that they meant to ask the Government to build a breakwater off Flagler's Point and perhaps another off the mouth of the harbor, to improve their anchorage-ground. I suggested to them that removing rocks was expensive work, and that if the breakwater could be arranged to cover the rocks, it would not be necessary to remove them. I made rough estimates from the Coast Survey charts of the probable cost of breakwaters from each side of the mouth of the harbor, one to extend to and cover Huron Rock, the other to extend to and cover Umbrella Rock, and the general opinion seems to be that, as the cost would not (apparently) exceed that of removing the rocks, it would be the better plan to adopt; and they wished an opportunity to consider it further when the map was platted and definite estimates could be made. The members of the club whom I spoke with were chiefly, Commodore Lowry, Vice-Commodore Allie, Treasurer Bushe, and Messrs. Coats and Murray, of the executive committee. From your recent letter from Commodore Lowry, I understand that the project for breakwaters is definitely abandoned, but, as directed by you, I submit herewith estimates both for removal of rocks and for breakwaters.

ESTIMATES OF COST.

On account of the exposed positions of Umbrella and Huron rocks, I do not think it would be safe to estimate the cost of their removal at less than $30 per yard, with 15 per cent. allowed for contingencies; though if the work could all be done under one contract it might be accomplished for less. North and South ledges are more sheltered and would have to be excavated to less depth, and a fair price for them would be $25 per yard. To remove Umbrella Rock to 12 feet, while the depth around it is 15 feet, would probably be unsatisfactory, and efforts would subsequently be made to have it taken out to 15 feet depth; it would be much more economical to take it out to 15 feet depth at first.

Umbrella Rock, removing to 12 feet depth, 1,657 cubic yards, at $30	$49,710
Add about 15 per cent. for contingencies	7,290
Total	57,000
Umbrella Rock, removing to 15 feet depth, 3,329 cubic yards, at $30	99,870
Add about 15 per cent. for contingencies	15,130
Total	115,000
Huron Rock, removing to 15 feet depth, 336 cubic yards, at $30	10,080
Add about 15 per cent. for contingencies	1,520
Total	11,600

North Ledge, removing to 9 feet depth, 3,024 cubic yards, at $25	$75,600
Add about 15 per cent. for contingencies	11,400
Total	87,000
South Ledge, removing to 11 feet depth, 2,773 cubic yards, at $25	69,325
Add about 15 per cent. for contingencies	10,375
Total	79,700

Omitting North and South ledges, whose removal is not asked for, the cost of removing Umbrella and Huron rocks to 15 feet depth would be $115,000+$11,600=$126,600. Or of removing Huron to 15 feet and Umbrella to 12 feet, $57,000+$11,600=$68,000.

BREAKWATERS.

Breakwaters in this position should be about 5 feet wide on top and built to 10 feet above low water (2½ feet above high water), with side slopes of one on one.

Such a breakwater to cover Huron Rock would be 930 feet long; the bottom is very hard and little or nothing need be allowed for settling. It would contain 23,000 tons of riprap.

Such a breakwater to cover Umbrella Rock would be 800 feet long; the bottom is quite soft, and 4 feet average should be allowed for settling. It would contain 42,000 tons of riprap.

Judging from prices obtained at David's Island sea-wall, riprap ought to be purchased for these breakwaters at $1.10 per ton; the depth is ample for any vessels, except at the shore ends and on the top of Umbrella Rock, and there is a harbor close at hand. It is not probable, however, that such rates could be obtained, and for purposes of this estimate the cost is placed at $1.40 per ton.

Cost of Huron Breakwater would be 23,000 tons of riprap at $1.40	$32,200
Add about 15 per cent. for contingencies	4,800
Total	37,000
Cost of Umbrella Breakwater would be 42,000 tons of riprap at $1.40	58,800
Add about 15 per cent. for contingencies	9,200
Total	68,000

or total cost for both breakwaters $68,000+$37,000=$105,000.

The clear opening between these breakwaters would be 930 feet, with depth of over 15 feet, or greater than obtains in the harbor above.

SUMMARY.

There are certain advantages which the plan for breakwater would have over the one for removing the rocks, and which I take the liberty of suggesting; some of them you would notice at once, others depend more or less on the nature and use of this particular harbor, and are apparent only on the ground or upon consideration of the map.

(1) The channels east of Huron Rock and west of Umbrella Rock are seldom used; during six days that I was at Larchmont I saw many vessels enter and go out, and do not remember one to have used those channels. The channel between the rocks is nearly as direct in any case; it is over 900 feet wide, and would amply accommodate all vessels using the harbor.

(2) The harbor is not secure enough in case of easterly gales; for three days during the survey a strong northeast wind was blowing and vessels had to go well up the harbor into shoal water. The harbor is more exposed to east and southeast gales than to northeast. The fact that certain members of the yacht club had considered the need of a breakwater shows that the harbor is not always secure.

(3) I was told that at some seasons of the year quite a number of oyster and fishing boats run in there for the night for shelter during storms; they would not be materially interested in having the rocks removed, but would be in having the safety of the harbor improved.

(4) These breakwaters would secure a shelter from storms of from 30 to 90 acres area, according to the direction of storms.

(5) Besides the evident economy, as appears in the estimates, it is impossible to tell in advance what submarine rock removal will cost, if let by contract; if done under successive small appropriations the cost might be considerably above the estimate.

A proper price for riprap can be much more readily ascertained, and if it were purchased at a favorable time, and excavation stone from New York City were accepted, the price might be much lower than the estimated cost per ton.

Respectfully submitted.

HENRY N. BABCOCK,
Assistant Engineer.

Col. D. C. HOUSTON,
Corps of Engineers.

D 24.

ESTABLISHMENT OF HARBOR-LINES OF STAMFORD HARBOR, CONNECTICUT.

LINDEN LODGE,
Stamford, Conn., November 11, 1889.

MY DEAR SIR: At the request of a number of friends here, and some of them influential in our district, I take the liberty of sending to you a petition, which they desire to have put before the Secretary of War in such way as may seem best to you, with the hope that if presented by you it may have immediate attention.

The Government, as you know, has spent a considerable sum of money in digging out the channel. A party here are about building out a pier or dock in such a way as to obstruct navigation and injure other property. These petitioners only ask to have the harbor-lines properly observed, which they learn can be done by the order of the Secretary of War, who will order a proper survey, and see that no unfair encroachment is made in the harbor, which, at the very best, is narrow.

I have no interest in this matter, beyond what I have to see no wrong done, which may injure navigation, and also the harbor of Stamford, if not opposed by the proper authority.

I have the honor to be, very truly yours,

JAMES D. SMITH.

Hon. JOS. R. HAWLEY,
United States Senate.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
November 25, 1889.

Respectfully returned to the Secretary of War.

Mr. James D. Smith, of Stamford, Conn., through Hon. Joseph R. Hawley, U. S. Senate, forwards petition of a number of citizens of that place, representing that certain parties threaten to erect and extend docks or wharves out into the harbor of Stamford, Conn., so as to seriously affect and injure the rights of navigation therein, and requesting that the War Department cause harbor-lines to be run, or take such other steps as will prevent encroachment upon the right of navigation in said harbor.

Section 12 of the River and Harbor act of August 11, 1888, provides that:

Where it is made manifest to the Secretary of War that the establishment of harbor-lines is essential to the preservation and protection of harbors, he may, and is hereby authorized, to cause such lines to be established, beyond which no piers or wharves shall be extended or deposits made except under such regulations as may be prescribed from time to time.

It appearing from the within petition that the establishment of harbor-lines is essential to the preservation and protection of the harbor of Stamford, Conn., it is recommended that proper steps be taken for their establishment. If this be approved, I further recommend that the subject be referred to a Board of Officers of the Corps of Engineers, to consist of Col. D. C. Houston, Lieut. Col. G. L. Gillespie, and Capt. Thos. L. Casey, whose duty it shall be to make the necessary examinations and investigations to enable them to report fully upon the matter and to indicate the lines proposed for adoption at as early a day as practicable.

It is also recommended that the expenses of the Board, including the cost of the required examination be paid by Col. D. C. Houston, Corps of Engineers, from the appropriation for "Improving harbor at Stamford, Conn."

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Second indorsement.]

NOVEMBER 27, 1889.

Approved as recommended by the Chief of Engineers.
By order of the Secretary of War.

SAM'L HODGKINS,
Acting Chief Clerk.

PETITION OF CITIZENS OF STAMFORD, CONNECTICUT.

STAMFORD, CONN., *November* 11, 1889.

Whereas the United States Government has within the past few years expended a large sum of money in deepening and improving the harbor at Stamford, Fairfield County, Conn., so that the same might be navigable at all tides; and

Whereas certain parties owning or occupying land adjoining said harbor are in the act of or threaten to erect and extend, without any legal right, docks or wharves out into the said harbor so as to seriously affect and injure the rights of navigation therein, and to a certain extent prevent the use of the channel of said harbor:

Now, therefore, the undersigned, citizens and tax-payers of said Stamford, and owners of land adjoining said harbor, respectfully request that you will cause an examination to be made into the condition of said harbor, and if deemed expedient, to cause a harbor-line to be run, beyond which no wharf or dock shall be allowed to be extended; or to take such steps, in such way as you may see fit, to prevent any encroachment upon the right of navigation in said channel and harbor, and your petitioners as in duty bound will ever pray.

(Walton Furguson and twenty-six others.)

REPORT OF BOARD OF ENGINEERS.

ENGINEER OFFICE, U. S. ARMY,
New York, February 24, 1890.

GENERAL: The Board of Officers of the Corps of Engineers, constituted by Special Orders, No. 78, Headquarters Corps of Engineers, U. S. Army, dated Washington, D. C., November 30, 1889, to establish harbor-lines in Stamford Harbor, Connecticut, has the honor to submit the following report:

In determining upon a system of harbor-lines for Stamford Harbor, it was thought advisable, first, to thoroughly examine the natural conditions, such as the existing shore-line, depth of water, and range of tides,

in connection with the present and prospective demands of commerce; and, second, to thoroughly weigh the conflicting personal interests which constituted the motive for the petition which was the immediate cause of the organization of the Board, this petition being dated November 11, 1889, and stating that—

Whereas certain parties owning or occupying land adjoining said harbor are in the act of or threaten to erect and extend, without any legal right, docks or wharves out into the said harbor so as to seriously affect and injure the rights of navigation therein, and to a certain extent prevent the use of the channel of said harbor:

Now, therefore, the undersigned, citizens and tax-payers of said Stamford, and owners of land adjoining said harbor, respectfully request that you will cause an examination to be made into the condition of said harbor, and if deemed expedient, to cause a harbor-line to be run, beyond which no wharf or dock shall be allowed to be extended, or to take such steps in such way as you may see fit to prevent any encroachment on the right of navigation in said channel and harbor, and your petitioners as in duty bound will ever pray.

Accordingly, on December 9, 1889, the Board proceeded to Stamford and made a preliminary examination of the entire harbor, carefully noting every circumstance and condition which might aid the members in defining a theoretical system of lines, subject to such modifications as the practical demands of the various riparian owners might, within certain limits, seem to require. It was ascertained also that the particular dock referred to in the petition had been completed and that the owners claimed that it was constructed under authority of an act of the legislature of the State of Connecticut.

A provisional system was soon after perfected by mutual discussion and laid down on a map drawn from careful and special surveys ordered by the Board, and it was resolved that these plans should be submitted to a committee of citizens of Stamford to be organized by their own selection. As a modification of this course, however, the plans were sent to Stamford, and the opinions of, and modifications suggested by, the riparian owners, taken down in writing. These opinions were laid before the Board and given as great consideration as possible, consistent with the efficiency of the general system.

The Board having taken into consideration the whole question of harbor-lines for Stamford Harbor, submits herewith a tracing (with description) of harbor-lines recommended for the upper portion of the harbor, embracing all existing wharves and those likely to be constructed in the near future. For the establishment of harbor-lines in the lower part of the harbor, additional surveys will be needed.

Fifteen thousand dollars have been appropriated for the improvement of this harbor, and have been applied to deepening and widening the low-water channel up to nearly the head of navigation. The original estimate for this improvement was $20,000, and $5,000 has been asked for to complete the project making a low-water channel 80 feet wide and 5 feet in depth. The mean rise of tides at this locality is about 8 feet and the high-water channel in the upper part of the harbor is about 400 feet in width. This high-water channel is utilized for vessels using the harbor and should be preserved as far as consistent with the necessities of commerce. The bottom of the harbor is generally soft, so that vessels may lie aground without injury. The improvement of the low-water channel by no means contemplated that wharves should be extended out to it.

Among the riparian owners there is but one who will be affected adversely in a pecuniary way by the lines here recommended, and this case calls, therefore, for special mention. Gillespie Brothers, who own the pier mentioned in the petition, projecting from the point on the eastern

side of the bay, are required to remove 62 feet of the pier in question to conform to the new pier line. On presenting the plans to interested parties the only opposer of the provisional pier line for this particular locality was the firm of Gillespie Brothers. The majority recommended a pier line drawn farther in toward the shore and the remainder were indifferent, coinciding with the opinion of the Board. In the system recommended below, therefore, the reduction of the said pier, made in the provisional system, has been adhered to.

The act of the legislature of the State of Connecticut, under which it is claimed that this pier was constructed, provides—

> That George A. Hoyt, of Stamford, be authorized to build a dock between high and low water mark adjoining his property at Waterside, so called, in the town of Stamford, commencing at a point in a line with the south line of his property, and running in a northeasterly direction 160 feet, and thence in a northwesterly direction 280 feet, following the channel and within 50 feet of the same. Said property being situated on the east side of Mill River and occupied as a lumber-yard.
>
> The position of the dock is indicated by the letter A on a map or diagram of the premises accompanying this resolution, and on file in the office of the Secretary of State. The area between said dock and said premises may be spiled and planked over, or filled in as may be most convenient.

This description is indefinite as to the point of commencement, and, if assumed to be at the point claimed by the owners, would carry the wharf entirely across the low-water channel. The pier as now constructed is evidently an encroachment on the high-water channel and should be removed to the pier-head line recommended. It consists simply of a pile-pier 6 feet wide, supporting a tramway, and can be removed at small cost.

Should further appropriations be made for this harbor, it would be advisable to widen the channel which makes a sharp bend in this vicinity to nearly the pier-head line recommended on the eastern side.

Respectfully submitted.

D. C. HOUSTON,
Colonel of Engineers.
G. L. GILLESPIE,
Lieut. Col. of Engineers.
THOS. L. CASEY,
Captain of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
February 27, 1890.

Respectfully submitted to the Secretary of War.

It being made manifest to the Secretary of War that the establishment of harbor-lines at Stamford Harbor, Connecticut, was essential to the preservation and protection of that harbor, he approved the recommendation of this office that a Board of Engineers be constituted to make the necessary examinations and investigations, and to indicate the lines proposed for adoption.

The Board constituted under this authority having given the subject careful consideration, submits the within report with a tracing and description of the harbor-lines recommended for the upper portion of Stamford Harbor, and states that additional surveys will be needed for the establishment of harbor-lines in the lower portion of the harbor.

It is recommended that the lines proposed by the Board, described within and delineated on the accompanying tracing for the west side of harbor and for the east side of harbor, be approved, and that the Secretary place his approval both upon the report and the tracing submitted.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Second indorsement.]

WAR DEPARTMENT, *February* 28, 1890.

Approved.

REDFIELD PROCTOR,
Secretary of War.

STAMFORD HARBOR, CONNECTICUT.

DESCRIPTION OF HARBOR-LINES AS RECOMMENDED FOR THE APPROVAL OF THE SECRETARY OF WAR BY THE BOARD OF ENGINEERS CONSTITUTED BY SPECIAL ORDERS, NO. 78, HEADQUARTERS CORPS OF ENGINEERS, DATED NOVEMBER 30, 1889, AT A MEETING HELD IN NEW YORK CITY, FEBRUARY 24, 1890.

West side of harbor.—Pier and bulkhead lines. Identical. Starting at the southeast corner of the west abutment of Oliver Street Bridge; thence following the present bulkhead on the east side of Schofield's and of White & Hanrahan's coal-yards to its southern end; thence following as nearly as may be the present high-water line of the filling on the south and west sides of White & Hanrahan's coal-yard by westerly, northwesterly, and northerly courses to the south end of White & Hanrahan's west bulkhead; thence following said bulkhead northwardly to the south side of the scale house; thence extending 190 feet on a course bearing magnetic S. 87° W.; thence extending 65 feet on a course bearing magnetic S. 35° W.; thence extending southeastwardly to a point in line of north face of Barrett's Dock produced and 20 feet east of said dock; thence extending southwardly parallel with and 20 feet distant from the east face of said Barrett's Dock to a point in line with the south side of said dock produced; thence extending westwardly to the southeast corner of said dock; thence extending southwardly to a point on "Lower White Rock" (near the west shore) 17 feet west from the vertical east face of said rock and there terminating.

East side of harbor.—Pier line.—Starting at the southwest corner of the east abutment of Oliver Street Bridge; thence extending southwardly and following the line of the present bulkhead as far as the west end of the jog at Frank's boat-house; thence extending in a straight line to the southwest corner of W. D. Smith's coal wharf; thence (omitting the distance across the mouth of the east cove) starting at the northwest pile of the wharf foundation just north of the Baryta Mill and extending in a straight line to a point on the north side of Gillespie Brothers' new wharf or landing, which point is 62 feet from the outer face of said landing measured along its north face: thence extending in a straight line to the northwest corner of Thomas's Dock; thence following the face of that dock to its southwest corner; thence extending in a straight line to the northwest corner of the old Steam-boat Dock; thence following along the face of that dock to its southwest corner and there terminating.

Bulkhead line.—Starting at the starting point of the pier line and following all its courses to the southwest corner of W. D. Smith's dock; thence (omitting the distance across the mouth of the east cove, about 286 feet) starting at the northwest pile of the wharf foundation, just north of Baryta Mills, and extending in a straight line to the northwest corner of the old Steam-boat Dock; thence following, with the pier-line, along the outer face of that dock to the southwest corner and there terminating.

And it is further provided that:

Wherever the above-described pier-lines lie so close to existing bulkheads that dredging can not be done up to such pier-lines without endangering the bulkheads, a landing not more than 5 feet in width may be built outside of such bulkheads, such landing to be supported on piles with an open water-way below.

This description refers to points existing at the date of this report, which will be referred to permanent marks.

APPENDIX E.

IMPROVEMENT OF HUDSON RIVER AND OF HARBORS OF RONDOUT AND SAUGERTIES, NEW YORK—REMOVING OBSTRUCTIONS IN EAST RIVER AND HELL GATE—IMPROVEMENT OF ENTRANCE TO NEW YORK HARBOR—IMPROVEMENT OF RIVERS AND HARBORS IN THE VICINITY OF NEW YORK AND IN NORTHERN NEW JERSEY.

REPORT OF LIEUTENANT-COLONEL G. L. GILLESPIE, CORPS OF ENGINEERS, OFFICER IN CHARGE FOR THE FISCAL YEAR ENDING JUNE 30, 1890, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Hudson River, New York.
2. Harbor of Saugerties, New York.
3. Harbor of Rondout, New York.
4. Harlem River, New York.
5. Removing obstructions in the East River and at Hell Gate, New York.
6. Newtown Creek, New York.
7. Buttermilk Channel, New York.
8. Gowanus Bay, New York.
9. New York Harbor.
10. Raritan Bay, New Jersey.

EXAMINATIONS AND SURVEYS.

11. Wappinger's Creek, from Wappinger's Falls to its mouth, New York.
12. East River, with a view to the removal of a ledge of rocks in the same, from the foot of Broome street to the foot of Twenty-third, in New York City.

HARBOR-LINES.

13. Establishment of harbor-lines in Hudson River, from Troy to Coxsackie, New York.
14. Establishment of harbor-lines of New York Harbor and its adjacent waters.

ENGINEER OFFICE, U. S. ARMY,
New York, N. Y., July 9, 1890.

GENERAL: I have the honor to transmit herewith annual reports for the fiscal year ending June 30, 1890, upon the works of river and harbor improvements under my charge.

Very respectfully, your obedient servant,

G. L. GILLESPIE,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

E 1.

IMPROVEMENT OF HUDSON RIVER, NEW YORK.

The Annual Report for 1885 contained a history of this improvement, accompanied by original reports and two sketches showing its condition at that time. This may be found in the Annual Report of the Chief of Engineers for 1885, Part I, page 667.

The only part of the Hudson River which has been improved by the General Government is the stretch about 20 miles long, beginning at the head of navigation at Troy, N. Y., about 6 miles above Albany, and extending down the river to New Baltimore, about 14 miles below Albany.

While there has always been enough water below New Baltimore for navigation, this upper section of the river, so far as its history is known to us, has always been obstructed by bars and shoals, due to the existence of numerous islands and sloughs, and the consequent diversion of the river's waters through too many channels.

Prior to 1831, when the jurisdiction of the Federal Government over these waters was confirmed by judicial decision, the State of New York had made efforts to improve the navigation of this part of the river.

Since 1831 the improvement of the Hudson River has been conducted both by the State of New York and by the General Government, both building and repairing dikes and doing such dredging as seemed necessary. In the last few years, however, the dike work has been left almost exclusively to the General Government, while the State of New York has done most of the dredging required.

The general system of improvement has been the same throughout, the contraction of the channels by the construction of jetties and dikes intended to deepen them by means of the scour so produced, and also deepening by dredging where it could not be dispensed with.

But up to 1831 the work, which had consisted almost entirely of the construction of spur-dikes and of dredging, had produced very little permanent improvement.

After 1831, however, the United States began the present general system of improvement, which consists of contracting the channel by means of longitudinal dikes intended to aid in scouring the bars and shoals, instead of using spur-jetties, as had been done previously.

Under this system the United States constructed two dikes in 1835, 1836, 1837, and 1838.

Then followed a long interval of time in which nothing was done by the United States, except in 1852; but in 1863, the State of New York took up the improvement on the general plan adopted by the United States in 1831, viz: substituting a system of longitudinal dikes instead of the jetty system, and between 1863 and 1867, built six important longitudinal dikes of this kind. (Annual Report of 1885, page 678.)

The work was taken up again by the United States in 1864, when, out of the general sum appropriated for river and harbor improvements, $33,000 was alloted for the Hudson River improvement, and this was followed by the act of June 23, 1866, which appropriated $50,000 for the same work.

The plans under which the present works of improvement of the river are conducted were adopted in 1866, and provide for securing a navigable channel 11 feet deep at mean low water from New Baltimore up to Albany, and 9 feet deep at mean low water from Albany up to Troy. The range of tides, determined in 1876, is 2 feet at Troy, 2.32 feet at Albany, and 3.43 feet at New Baltimore.

The following is a description of the plan:

First. A system of longitudinal dikes to confine the current sufficiently to allow the ebb and flow of the tidal current to keep the channel clear; these dikes to be gradually brought nearer together from New Baltimore towards Troy, so as to assist the entrance of the flood current and increase its height, their height to be kept approximately at the level of the tidal high water, so as not to confine the freshets, the exact level, however, being left to be determined by experience, as the work progresses.

Second. That the dredge be used, so far as necessary, to open the channels above described, which the current should not be allowed to do, except very gradually, lest accumulations dangerous to navigation be formed below.

Third. Keeping, as far as practicable, the side reservoirs open to the passage of tidal currents by gaps at their lower extremities, in order to increase the tidal flow.

Fourth. Dumping all dredged material in secure places, where it can not be moved back again into the channel by the current.

Fifth. Constructing the dikes of timber and stone, in a manner to secure their permanency, at a minimum cost, the details varying with the locality, to be left to the discretion of the local engineer, to be so designed as to admit of having an increased height given to the dikes if necessary.

Sixth. To protect, when necessary, the banks and islands against the abrading action of the current by revetments.

Seventh. That limits, beyond which no encroachments upon the channel should be made, be prescribed, and that any such encroachments be reported to the engineer in charge.

The estimated cost of this improvement was $862,297.75. This estimate was increased several times at later periods, to take account of expenditures for repairs and for work done not included in previous estimates, and was given in 1882 as $1,078,304.47. The last revised estimate is given in the annual report for 1889, where it is stated that the cost for the construction of the new works and for the repair of the old ones is $370,105, increasing the estimate for work from the beginning to $1,424,435.

After timber has been exposed for eight or ten years it decays very rapidly, and the structures formed by it are liable to serious injury from slight causes, whether ice, freshets, or collisions. It is not surprising, therefore, that the cost for repairs increases annually, and that the appropriations of the past few years, which were small relatively, had to be applied chiefly to strengthening old work. The pile-dikes existing on both banks from New Baltimore to Albany are in a very bad condition. In many places the original structure has been carried away, excepting the stone filling, which has been leveled off to a gentle slope, and generally the timber-work of the structures which remains standing needs large expenditures both for timber and stone.

From the nature of the materials which enter into the construction of the dikes, and from the limited sums which can be applied annually to renew the parts which become unserviceable, whether by natural decay or otherwise, it can be well understood that the estimates prepared from time to time for the completion of the project can be accepted as approximately accurate for only a short period of time. This statement seems necessary for a correct understanding of the apparent discrepancy between the estimated cost of the project and the sums which have been appropriated for its execution.

The State of New York makes an appropriation at every session of its legislature for the improvement of the Hudson River, and prior to 1867 the money was applied to the construction of dikes on the left bank of the river from Hotaling Island to Albany, to jetties, dams, and to temporary measures of relief, and also to dredging at the points where shoals were discovered after the spring freshets. In the last few years, however, the dike work has been left almost exclusively to the General Government, while the State has done the most of the dredging. The manner in which the dredged material has been disposed of is very objectionable. Instead of being carried directly to a secluded dumping-ground remote from the action of the currents of the river, where its deposit will be beneficial in strengthening the dikes and cross-jetties, it is frequently deposited, possibly without the knowledge of the State superintendent of public works, directly into the channel along the face of the dikes or upon the dikes, where it is readily washed back into the channel. This method, which has a tendency to produce shoals at points where deep water previously existed, has been detrimental to the navigation of the river, but will hereafter be prevented by regulations accompanying the establishment by the Government of harbor lines.

The Albany State board of pilots, in a letter addressed to the Secretary of the Treasury, dated September 13, 1889, complained that the navigation of the Hudson River below Troy, N. Y., had been seriously damaged by reason of illegal dumpings of material into the river by the Troy Iron and Steel Company and others. The complaint was referred later to the Secretary of War, and on the 1st of November, 1889, the harbor line board for New York Harbor and adjacent waters, tributary thereto, was directed to recommend harbor lines along the Hudson River, from Troy, N. Y., to Coxsackie, N. Y., to comply with section 12 of the river and harbor act of August 11, 1888, which provides for the establishment of such lines, "beyond which no piers or wharves shall be extended or deposits made, except under such regulations as may be prescribed from time to time by him (Secretary of War)."

The lines recommended by the harbor line board for the Hudson River between Troy and New Baltimore, N. Y., received the approval of the Secretary of War March 25, 1890, and a copy of the map which contained the water-front of the Troy Iron and Steel Company, a short distance below Troy, was sent from this office to the State engineer of New York May 3, 1890, inviting his attention to the lines which had been established by the Secretary of War, and the manner in which the Troy Iron and Steel Company had violated the State law of 1879 in regard to dumping. The company was likewise given the same information. It is expected that the establishment of the harbor lines for the river will prevent in the future the deterioration of the navigation of the river by dumping into the channel or by trespass from the shore lines.

The following statements in regard to the physics of this river have been prepared by the assistant engineer in charge:

The Hudson River, which rises in Essex and Hamilton counties, in the Adirondack Mountains and flows in a southerly course to the Atlantic Ocean at New York, receives above the State dam at Troy the Little Wood Creek, Batten Kill, Fish Creek, Hoosic and Mohawk rivers, which embrace the drainage area of seven counties, covering 4,064,000 acres. (See report of State Engineer, State of New York, for 1868, pages 42 and 43.)

The average rainfall covering the past 63 years, from observations recorded in the report of the water commissioner at Troy, N. Y., for 1889, is 36.55 inches. The greatest rainfall in any year was recorded in 1878, when 49.23 inches fell; the least

rainfall in any one year occurred in 1839, when 18.32 inches fell. The greatest known rainfall in any one month occurred in October, 1869, when 13.8 inches fell; the least known rainfall in any one month was in May, 1840, when only 0.2 of an inch fell.

At times during the dry season of most every year, for a month at least, no water flows over the State dam at Troy, and excepting what comes in through the lockage of the canals, there is during that period little apparent fresh-water supply to the flow of the river. From this, and the fact that the tide rises and falls at the State dam, it is evident that the navigation of the Hudson River at the low stage is dependent upon the tidal prism of the river.

The mean rise and fall of tides at—

	Feet.
State Dam, Troy, N. Y	0.80
Nail Works, Troy, N. Y	1.92
Albany, N. Y	2.32
Castleton, N. Y	2.53
New Baltimore, N. Y	3.42
New York, Governor's Island, from Coast Survey	4.40

The mean duration of rise of tide at Albany is five hours and the mean duration of fall seven hours twenty-five minutes.

The elevation of mean low water at New York below that at—

	Feet.
New Baltimore	3.55
Castleton	4.35
Albany	4.78
Troy Nail Works	5.32
Troy State Dam	6.88

This shows the slope of mean low water between State Dam and Albany to be 2.10 feet, and between State Dam and New Baltimore 3.33 feet, which is nearly equal to the slope between New Baltimore and New York, 3.55 feet.

The elevation of mean high water at New York below that at—

	Feet.
New Baltimore	2.57
Castleton	2.48
Albany	2.70
Nail Works, Troy	2.84
State Dam, Troy	3.28

The elevation of the plane of mean tide at New York below that at—

	Feet.
New Baltimore	3.06
Castleton	3.41
Albany	3.74
Nail Works, Troy	4.08
State Dam, Troy	5.08

Through the courtesy of Mr. Walter Katté, the chief engineer of the New York Central and Hudson River Railroad Company, the elevation of the base of rail of the Albany branch track of the West Shore Railroad at its junction with the Delaware and Hudson Railroad at Kenwood Junction, Albany, is given as 17.15 feet above the plane of mean high water at Weehawken, referred to a bench-mark established in Hoboken by the United States Coast Survey. This elevation was determined from a line of levels run in connection with the location and construction of the West Shore Railroad.

By connecting this point, which is 14.45 feet above mean high water at Albany, with our datum, and using the planes of mean high water and mean low water from tidal observations of 1876 and corrected in 1884, the above tables are computed.

In the report of 1873, made by James F. Gardner, geographer to the Department of the Interior, the elevation of mean tide at Albany above that of the Atlantic Ocean is given at 4.84 feet as against 3.74 feet from above table.

The heights of the greatest known freshets above the plane of mean low water at Albany are as follows:

That of February 9, 1857, due to an ice gorge at Van Wie's Point, was 22.19 feet.

That of October, 1869, due to the great rainfall in that month, which reached 13.8 inches, was 19.04 feet.

That of February, 1886, due to an ice gorge, was 17.89 feet.

Generally speaking, the effects of rain-storms are shown by a rise in the river within twenty-four hours. The winds also materially affect the height of water; south and east winds drive the water up the river, causing very high tides, while a north or west wind produces an opposite effect.

BRIDGES ACROSS THE HUDSON RIVER.

The following table gives the location and essential features of all the bridges which cross the line of navigation of the river:

Name and location of bridge.	Draw-span.		Width in clear in each draw.		Height of bottom chords above mean high water.		Remarks.
	Ft.	*In.*	*Ft.*	*In.*	*Ft.*	*In.*	
New York Central and Hudson River Railroad Bridge at Bridge Avenue, Troy, N. Y.	198	6	61	6	23	10	Single draw; railroad, wagon, and passenger bridge; iron on stone piers; draw-pier on land, east shore; at right angles to stream, 6 piers in river; draw opened by steam power.
Congress Street Bridge, Troy, N. Y.	258	0	104	0	29	6	Double draw; wagon and passenger bridge; iron, on stone piers, slightly oblique to direction of stream; 2 piers and draw-pier in river: draw opened by hand power.
New York Central and Hudson River Railroad Upper Bridge, Albany, N. Y.	275	0	110	7	33	5	Double draw; railroad freight bridge; iron, on stone piers, at right angles to stream; 4 piers and draw-pier in river between bulkhead lines; draw opened by steam power.
New York Central and Hudson River passenger railroad bridge, Albany, N. Y.	275	0	115	4	28	1	Double draw; railroad and passenger bridge; iron, on stone piers, at right angles to stream; 4 piers and draw-pier in river; draw opened by steam power.
Lower Bridge, Greenbush Bridge, Albany, N. Y.	400	0	160	8	22	7	Double draw; wagon and passenger bridge; iron, on stone piers, at right angles to stream; 2 piers and draw-pier in river; draw opened by steam power.
The Poughkeepsie Bridge, Poughkeepsie, N. Y.	.....		.....		130	2	No draw; railroad bridge; iron, on iron piers with stone foundations, at right angles to stream; 4 piers in river; 5 spans, 548 feet, 525 feet, 548 feet, 525 feet, and 548 feet; cantilever bridge.

WORK DONE DURING THE FISCAL YEAR.

On the 22d of June, 1889, a project was submitted to the Chief of Engineers for the application of the appropriation, act of August 11, 1888, $75,000, together with the balance of $20,064.28 available from former appropriations, giving a total aggregate amount available for construction of $95,064.25. The places where this sum was to be applied for repairs and reconstruction were as follows:

Barren Island Dike	$3,350
Roah Hook Dike	525
Mull's Dike	22,500
Shad Island Dike	450
Cedar Hill Dike	12,000
Cedar Hill Single Pile Dike	50
Winnie's Dike	3,200
Stone Light Dike, Van Wie's Point	3,000
Papscannee Dike, Section III	2,500
Papscannee Dike, Section II	1,750
Papscannee Dike, Section I	11,500
Abbey Channel Dike	1,500
Bogart's Island Dike	3,750
Small Island Dike	1,600
Douw's Point Dike, extension south	2,750
Douw's Point Dike	1,600
Bath Dike	2,300
Base Island Pile	1,950
High Dike	8,000
Port Schuyler Dike	3,500
Total	87,775

It will be noticed that the entire money available was recommended to be applied towards repairs, and the reason given in the project for this method of using the appropriation was that some of the dikes had never been repaired since they were built ten or fifteen years previously, and were in very bad condition, while others comparatively new had been so injured by freshets and ice that their serviceability was much impaired, and that as a rule all the single-pile dikes had been almost completely destroyed.

The project was approved, and on the 2d of July sealed proposals were invited by public advertisement, to be publicly opened August 6, for the supply of the necessary materials. The lowest bidder was Mr. John Kelly, the terms of whose bid are given in the appended abstract, and the contract was made with him August 31, 1889. On the 20th of September Mr. Kelly began work under his contract, which is still in progress at the close of the year.

The materials to be provided by this contract were delivered so slowly and so unsatisfactorily that it was feared all the weather favorable for construction would be sacrificed unless materials were otherwise obtained. Letters were written accordingly to stone dealers along the Hudson and in New York City inviting proposals for the delivery below Van Wie's Point, principally in Mull's and Cedar Hill dikes, of 10,000 or more tons of stone by December 30, and on the 7th of October an open-market agreement was made with the Bouker Contracting Company, of New York City, for the supply of the quantity asked for at the prices paid to the contractor, Mr. Kelly. The agreement was acted upon at once, and the Bouker Contracting Company did all that was possible to comply with the terms of the agreement, but owing to unavoidable circumstances were not able to deliver more than 5,119.9 cubic yards within the time agreed upon. On the opening of spring the agreement was extended, and the quantity required was all delivered by June 7, 1890.

The lower prices at which the materials had been contracted for left a small balance for application at other points. On the 3d day of March, 1890, sealed proposals were opened for building a timber and stone dike at Mull's Plaat, 12 miles below Albany, on the left bank of the Hudson River, to arrest threatened scourings on that bank arising from the extension of the dike at Mull's, on the opposite shore. The contract was awarded to William Fuller & Sons, the lowest bidders, according to the terms of their bid given in the appended abstract. The contractors began work in June, and at the close of the fiscal year fair progress has been made.

The progress which has been made during the year in the repair and construction of dikes under contract and under open-market agreements may be summarized as follows:

Barren Island Dike.—This dike had become damaged by undermining, resulting from scour. Work of repair and protection of the lower 400 feet was begun in November and was completed in December. A row of pine piles, 5 feet apart, was driven in front and in rear of the old dike and secured by walling timbers and tie-rods. The remainder of the dike, where settlement had taken place, was filled with stone, of which 342 cubic yards were used. A small amount of stone filling is still required.

Roah Hook Dike.—Three hundred and eighty-five cubic yards of stone have been put into the dike to refill settlements. This was done

during the fall of 1889, since which time some settlement has taken place, and an additional amount will be required.

Mull's Dike.—This dike consisted originally of a single row of piles, tied together by longitudinal timber and partially riveted on both sides with stone. The timber work had been destroyed and the stone slopes had been leveled when the repairs were undertaken.

The remains of the lower end, adjacent to the stone beacon, for a distance of 700 feet north will be covered by an embankment of stone rising to a high-water level. This embankment will be 5 feet wide at top and will have natural slopes. Above the low-water level the stone will be placed with some regard to bond. For a distance of 1,400 feet south of the beacon the extension of the dike will be of stone laid with care so that the structure when completed will be of permanent character.

At the close of the fiscal year 14,514.9 cubic yards of small stone and 451.8 cubic yards of large stone had been delivered and put in place, and the structure had been completed for a length of 100 feet, and the residue brought up to or above low water.

A few clusters of piles have been driven along the outer face of the dike to mark its alignment during freshets.

Mull's Plaat Dike.—This improvement begins near Mull's light-house, on the east shore, and runs down-stream for a distance of 2,950 feet, closely following the natural bank of the river. The plans provide for a single row of piles driven to a full penetration of not less than 10 feet, 5 feet apart, and sawed off at the elevation of mean low-water. Behind and against this row of piles two courses of round timber are placed below low water, the whole forming a footing for a stone embankment 5 feet wide on top, to be built in rear to a height of 2 feet above mean high-water. It constitutes a bank revetment rather than a training-dike.

Shad Island Dike.—A breach 125 feet long which had occurred in the lower end of this dike was closed with piling securely tied with waling timbers and the settlements partially filled with stone. One hundred and eighty cubic yards have been supplied. The repairs are not yet finished.

Cedar Hill Dike.—This dike, a double-pile dike with stone filling, was built in 1867, since which time it has received little or no repair. In consequence the timber work had very much deteriorated and a breach of 300 feet had occurred. In addition, the stone filling had settled throughout the whole length.

A stone embankment has been built, closing the breach and covering in all 2,500 feet of dike, 4,683 cubic yards of stone being used. The upper end, for 325 feet adjacent to the present dock, will be repaired by driving a row of piles in front, connecting them by waling timbers and tying them back to anchor piles in the rear, then filling with stone. One thousand feet of the lower end will also require stone filling.

Cedar Hill Single-Pile Dike was provided with new fender-piles.

Winnie's Dike.—Five hundred feet of this dike adjacent to the channel was in bad condition, having been undermined and tilted over.

This dike is being provided with a new timber-face, a close row of piles connected with double waling timbers and fastened to rear anchor piles every 4 feet. Owing to freshets the timber work was much delayed, but is now nearly completed. A small amount of stone filling is to be placed in this dike.

Stone Light Dike, Papscannee Dikes (sections I, II, and III), Abbey Channel Dike, Bogart's Island Dike, and Small Island Dike.—The repairs contemplated for these dikes, which consist of refilling and revetting with stone, have not yet been commenced.

Douw's Point Dike, Extension South, is being refilled and revetted, 1,931.87 cubic yards stone having been put in place.

Douw's Point Dike is also being refilled and revetted; 1,200 cubic yards of stone have been put in place.

Bath Dike, Base Island Pile Dike, and High Dike.—The repairs contemplated for these dikes have not yet been commenced.

Port Schuyler Dike.—This dike was only partially repaired during 1889. On account of the continuous freshets this spring work has not been resumed, a very low stage of the river being required for successful work.

Under the authority of the Chief of Engineers, dated March 22, 1890, a re-triangulation of the river from Troy to Coxsackie, and a re-establishment of the bench-marks, was begun in April. This work, which has been pushed as rapidly as the weather and high water would permit, is still in progress. Sixteen miles of the river from New Baltimore to Forbes' Dock, above upper bridge at Albany, have been triangulated, the State survey stations of 1887 have been connected with our system, dock-lines and ice-houses not located on the maps of the 1884 survey have been located, and in every case triangulation points have been established in as permanent a manner as possible, every point being referenced in by distances and bearings to two fixed points. Levels have also been run covering 48.8 miles and bench-marks re-established between Albany and Stuyvesant.

The permanent works remaining to be built in order to complete the improvement as originally projected are:

1. Completion of dike from Staat's Island to Campbell's Island Dike.
2. Completion of dike from Schermerhorn to Shad Island.
3. The proposed improvement below Shad Island and Mull's Plaat.
4. The improvement at Willow Island.
5. The construction of a new dike below Nine Mile Tree.
6. The extension of the dike at Mull's Plaat (partly contracted for).

The project contemplates also the removal of the Overslaugh Rock, near Van Wie's Point. This rock lies nearly in mid-channel and ought to be removed as early as practicable, as it is a great obstruction to the navigation of the river.

The cost of the completion of these new works is estimated at $135,000.

Mr. Charles G. Weir, assistant engineer, has been in personal charge of this improvement during the year, and has conducted his work with efficiency and economy.

This work is in the collection district of New York, Albany being a port of entry.

AMOUNTS APPROPRIATED.

By act of Congress approved—	
June 30, 1834	$70,000.00
July 2, 1836	100,000.00
March 3, 1837	100,000.00
July 7, 1838	100,000.00
August 30, 1852	50,000.00
	420,000.00

AMOUNTS APPROPRIATED FOR PRESENT PROJECT.

By act of Congress approved—	
June 26, 1864, allotment	33,000.00
June 23, 1866	50,000.00
March 3, 1867	305,188.00
July 25, 1868	85,000.00
April 10, 1869	89,100.00
July 11, 1870	40,000.00
March 3, 1871	40,000.00
June 10, 1872	40,000.00
March 3, 1873	40,000.00
June 23, 1874	40,000.00
March 3, 1875	40,000.00
August 14, 1876	50,000.00
June 18, 1878	70,000.00
March 3, 1879	30,000.00
June 14, 1880	20,000.00
March 3, 1881	15,000.00
By act of Congress passed August 2, 1882	10,000.00
By act of Congress approved—	
July 5, 1884	30,000.00
August 5, 1886	26,250.00
August 11, 1888	75,000.00
Total	1,128,538.00
Received from other sources	792.57
	1,129,330.57
Amount expended to June 30, 1890, inclusive of outstanding liabilities	1,074,485.65

Money statement.

July 1, 1889, amount available		$94,856.28
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$31,365.05	
July 1, 1890, outstanding liabilities	8,656.35	
July 1, 1890, amount covered by uncompleted contracts made during the fiscal year ending June 30, 1890	44,396.15	
		84,417.55
July 1, 1890, balance available		10,438.73
Amount appropriated by act of September 19, 1890		150,000.00
Amount available for fiscal year ending June 30, 1891		160,438.73
Amount (estimated) required for completion of existing project		145,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892		145,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for repairing dikes in the Hudson River, between New Baltimore and Troy, N. Y., received in response to the advertisement dated July 2, 1889, and opened August 6, 1889, by Lieut. Col. G. L. Gillespie, Corps of Engineers, U. S. Army.

Material, etc.	1. John A. Bouker.		2. John Kelly.*		3. C. A. Brown and John Fleming.	
	Per unit.	Amount.	Per unit.	Amount.	Per unit.	Amount.
Pine or spruce piles (10,600 linear feet), linear foot	$0.15	$1,590.00	$0.15	$1,590.00	$0.20	$2,120.00
White-oak piles (210 linear feet)..linear foot..	.30	63.00	.27	56.70	.30	63.00
Square timber yellow pine (14,500 feet B. M) M feet, B. M..	38.00	551.00	43.00	623.50	45.00	652.50
Sheet piling, yellow pine (5,000 feet, B. M.), M feet, B. M	40.00	200.00	43.00	215.00	45.00	225.00
Iron tie-rods and screw-bolts (4,150 pounds), pound	.07	290.50	.04	166.00	.05	207.50
Drift-bolts, spikes, washers, etc. (1,150 pounds) pound..	.06	69.00	.06	69.00	.05	57.50
Quarry spalls or gravel (200 cubic yards), cubic yard	1.40	280.00	1.00	200.00	1.25	250.00
Stone paving (1,000 square yards), square yard	1.00	1,000.00	2.38	2,380.00	2.25	2,250.00
Ordinary rubble-stone furnished by bidder (17,200 cubic yards) cubic yard..	1.40	25,456.00	1.05	18,060.00	1.40	24,080.00
Ordinary rubble-stone furnished by United States (17,200 cubic yards) cubic yard..	1.38	23,736.00	1.10	18,920.00	1.40	24,080.00
Large stone furnished by bidder (22,450 cubic yards) cubic yard..	1.48	33,226.00	1.30	29,185.00	1.40	31,430.00
Large stone furnished by United States (22,450 cubic yards) cubic yard..	1.38	30,981.00	1.35	30,307.50	1.40	31,430.00
Dredging (1,000 cubic yards) cubic yard..	.90	900.00	.85	850.00	.20	200.00
Total amount (stone furnished by bidder)	.....	62,625.50	.....	53,395.20	.....	61,535.50
Total amount (stone furnished by United States)	.....	59,669.50	.....	53,377.70	.....	61,535.50

Material, etc.	4. William D. Fuller.		5. Charles C. Cotte.		6. Leonard A. Marshall.		7. Francis H. Smith.	
	Per unit.	Amount.	Per unit.	Amount.	Per unit.	Amount.	Per unit.	Amount.
Pine or spruce piles (10,600 linear feet) linear foot..	$0.11½	$1,258.75	$0.25	$2,650.00	$0.28	$2,968.00	$0.30	$3,180.00
White-oak piles (210 linear feet), linear foot	.23	48.30	.30	63.00	.50	105.00	.35	73.50
Square timber, yellow pine, (14,500 feet, B. M.) M feet, B. M..	39.00	565.50	85.00	1,232.50	54.00	783.00	55.00	797.50
Sheet piling, yellow pine, (5,000 feet, B. M.) M feet, B. M..	45.00	225.00	45.00	225.00	54.00	270.00	55.00	275.00
Iron tie-rods and screw-bolts (4,150 pounds) pound..	.05	207.50	.06	249.00	.10	415.00	.08	332.00
Drift-bolts, spikes, washers, etc. (1,150 pounds) pound..	.03¾	43.13	.05	57.50	.10	115.00	.08	92.00
Quarry spalls or gravel (200 cubic yards) cubic yard..	.98	196.00	1.50	300.00	2.00	400.00	1.65	330.00
Stone paving (1,000 square yards), square yard	1.60	1,600.00	3.00	3,000.00	2.50	2,500.00	1.90	1,900.00
Ordinary rubble-stone furnished by bidder (17,200 cubic yards), cubic yard	.97	16,684.00	1.50	25,800.00	1.75	30,100.00	1.59	27,348.00
Ordinary rubble-stone furnished by United States (17,200 cubic yards) cubic yard..	3.00	51,600.00	1.50	25,800.00	1.75	30,100.00	.....	.....
Large stone furnished by bidder (22,450 cubic yards) cubic yard..	3.98	89,351.00	1.70	38,165.00	1.75	39,287.50	1.59	35,695.50
Large stone furnished by United States (22,450 cubic yards), cubic yard	5.00	112,250.00	1.70	38,165.00	1.75	39,287.50	.....	.....
Dredging (1,000 cubic yards), cubic yard	1.00	1,000.00	.50	500.00	.35	350.00	.30	300.00
Total amount (stone furnished by bidder)	.....	111,179.18	.....	72,242.00	.....	77,293.50	.....	70,323.50
Total amount (stone furnished by United States)	.....	168,994.18	.....	72,242.00	.....	77,293.50	.....	.....

* Lowest bid.

Abstract of proposals for building a timber and stone dike in the Hudson River at Mull's Plaat, 12 miles below Albany, N. Y., received in response to the advertisement dated February 3, 1890, and opened March 3, 1890, by Lieut. Col. G. L. Gillespie, Corps of Engineers, U. S. Army.

No.	Name of bidder.	Pine or spruce piles (10,000 linear feet).		Round timber, (5,900 linear feet).		Square timber (18,000 feet B. M).	
		Per linear foot.	Amount.	Per linear foot.	Amount.	Per M feet B. M.	Amount.
		Cents.		*Cents.*			
1	J. V. Hoag, jr	19	$1,900.00	13	$767.00	$40.00	$720.00
2	Leonard A. Marshall	15	1,500.00	10	590.00	45.00	810.00
3	Richard Parrott	25	2,500.00	15	885.00	45.00	810.00
4	William Fuller & Sons*	11⅞	1,187.50	7⅞	464.63	39.00	702.00
5	J. L. Powley	15	1,500.00	12½	737.50	44.00	792.00
6	John A. Bouker	12	1,200.00	10	590.00	45.00	810.00
7	John S. Gillies	30	3,000.00	20	1,180.00	60.00	1,080.00
8	Frederick J. Kelly	25	2,500.00	15	885.00	40.00	720.00
9	William Parrott	13	1,300.00	9	531.00	40.00	720.00

No.	Name of bidder.	Iron spikes and wire (3,500 pounds).		Rubble-stone (2,000 cubic yards).		Large stone (4,000 cubic yards).		Total amount.
		Per pound.	Amount.	Per cubic yard.	Amount.	Per cubic yard.	Amount.	
		Cents.						
1	J. V. Hoag, jr	5	$175.00	$1.20	$2,400	$2.50	$10,000	$15,962.00
2	Leonard A. Marshall	6	210.00	1.45	2,900	1.45	5,800	11,810.00
3	Richard Parrott	5	175.00	1.10	2,200	1.55	6,200	12,770.00
4	William Fuller & Sons*	3⅞	135.63	.94	1,880	1.28	5,120	9,499.76
5	J. L. Powley	4	140.00	1.30	2,600	2.00	8,000	13,769.50
6	John A. Bouker	5	175.00	1.20	2,400	1.40	5,600	10,775.00
7	John S. Gillies	8	280.00	2.00	4,000	2.00	8,000	17,540.00
8	Frederick J. Kelly	8	280.00	1.15	2,300	1.35	5,400	12,085.00
9	William Parrott	4	140.00	1.10	2,000	1.40	5,600	10,421.00

* Lowest bid.

COMMERCIAL STATISTICS.

Special care has been taken to ascertain an approximate estimate of the amount and value of the commerce of the Hudson. The assistant engineer in charge has given the matter his personal attention, and in a special report makes the following statement:

"The efforts to secure this information through correspondence not being wholly successful, every shipping point on the river has been visited by me, in person, and information gotten and verified in this way. The importance of the Hudson as a great water-way of commerce is apparent when it is known that aside from its own local traffic, which in itself is very large, it absorbs all the traffic of the Erie, Champlain, and Delaware and Hudson Canals, besides the great coal trade of the Pennsylvania Coal Company, at Newburgh, and the Erie coal trade at Piermont. The average season of navigation of the river is two hundred and forty days, and that of the canals two hundred and twenty days.

The Erie Canal, extending from Albany to Buffalo, on Lake Erie, a distance of 352 miles, with a difference of level of 577 feet, and to Oswego, on Lake Ontario, connects the Great Northern Lakes with the Hudson River and brings in immense commerce from the Northwest and Canada. The principal items of this commerce are lumber and grain.

The Champlain Canal, 69 miles long, connects Lake Champlain with the Hudson River. This lake, which is 93 feet above tide-water of the Hudson, and whose waters flow into the St. Lawrence, is connected by the Chambly Canal with the St. Lawrence River below Montreal. The principal items of tonnage on this canal are lumber and iron ore. The above canals, with 575 miles of subsidiaries, constitute the New York State canals. The Erie Canal enters the Hudson by three tide-water locks, one

at the foot of Twenty-third street, West Troy; one at foot of Eighth street, West Troy, and a third at the lumber district, Albany.

The Champlain Canal enters the river at Waterford, 3 miles above the State Dam, and boats are locked through the dam to tide-water. It is also connected with the Erie Canal, and through its tide-water locks with the Hudson River.

The Delaware and Hudson Canal enters the Hudson through Rondout Creek at Rondout, N. Y., and brings the anthracite coal country at Honesdale and the Delaware River into water communication with the Hudson. The principal items of tonnage on this canal are coal, bluestone, and cement. Aside from the above feeders to the commerce of the Hudson, the Pennsylvania Coal Company has a large tide-water coal depot at Newburgh, where, also, the Erie Railroad has a terminal point and transfers large quantities of freight by boat across the river. The Erie Railroad also has a coal depot at Piermont, 20 miles above New York, where preparations are being made to handle a very large supply.

The following statistics include the tonnage received at all points above Spuyten Duyvil Creek, and of the local shipments between points on the river, only that shipped is credited to the points from which it was shipped, no entry being made to the total tonnage of the amount received at local points from other local points. The total tonnage also includes all through freight shipped from points up the river that passed the mouth of Spuyten Duyvil Creek going south.

The two principal industries on the river which add materially to the total tonnage are ice and brick. The capacity of the ice-houses on and adjacent to the river exceeds 4,000,000 tons, and amount generally harvested 3,500,000. The brick manufactured on the river exceeds 850,000,000.

Total tonnage of all shipping points on the Hudson River during 1889, not including the tonnage, coming through State canals .....tons..	15,033,309
Value of same	$278,196,094
Total tonnage coming to and leaving tide-water through State canals, 1889 .....tons..	3,592,437
Value of same	$108,000,000
Increase of same over tonnage, 1888 .....tons..	326,466
Grand total, tonnage of the Hudson River, including the tonnage through State canals .....tons..	18,582,596
Value of same	$485,733,094

This does not include the value of vessels carrying the above trade, which are equally exposed to the dangers of navigation.

Total number of vessels registered at Albany, 1889	515
Total tonnage of same .....tons..	73,921
Total value of imports at port of Albany, 1889	$852,271.00
Total duties collected on same	156,493.52
Number of transportation companies for passengers or freight, not including individual steam-boats or pleasure boats	30
Total number of passengers carried, 1889	5,000,000
Total population along the river	450,000

No new transportation lines have been established during the year.

Accompanying this report I herewith hand you a tracing showing the Hudson River and its canal connections with the Great Lakes and the St. Lawrence River; also a detailed record of the statistics of the river as I have gathered them, with the addresses of parties through whom the information was gotten."

E 2.

IMPROVEMENT OF SAUGERTIES HARBOR, NEW YORK.

The harbor of Saugerties is the name applied to the mouth of Esopus Creek, which empties into the Hudson River, on the west shore, about 100 miles above the city of New York. With the exception of some slight works undertaken by the inhabitants, giving no permanent results, nothing had been done towards the improvement of this harbor until it was undertaken by the United States Government in 1887. In 1883 a survey of the harbor was made under the direction of the engineer officer in charge, which indicated that there was a shoal at the entrance

1,100 feet wide, between 6-foot contours, over which the least depth was 3 feet, mean low water. Two plans of improvement were recommended, both providing for the construction of parallel dikes, and for dredging the channel between them 7 feet deep, mean low water. (See Annual Report of the Chief of Engineers for 1884, Part I, page 716.)

A re-examination of the harbor, made in 1887, after the State had done some dredging in the channel, resulted in the submission of a third project, differing from those previously submitted only in the direction given to the dikes. The range of tides is 4 feet, approximately.

The project of 1887 was approved and its execution was begun the same year.

Its estimated cost was as follows (see Annual Report of the Chief of Engineers for 1887, Part I, page 662):

North dike, 2,300 feet long:	
Pile-work, 2,160 running feet, at $7 per foot	$15,120
Crib-work, 140 running feet, at $30 per foot	4,200
South dike, 2,300 feet long:	
Pile-work, 2,200 running feet, at $7 per foot	15,400
Crib-work, 100 running feet, at $30 per foot	3,000
Dredging, 30,000 cubic yards, at 25 cents	7,500
Contingencies, about 15 per cent	6,780
Total	52,000

The appropriations of 1884 and 1886, aggregating $20,000, were applied in the building of the south dike, and when work was suspended in 1887 that dike had been completed for a length of 2,363½ feet.

At the close of the fiscal year ending June 30, 1889, two contracts were in force for the expenditure of the appropriation of August 11, 1888, $12,000; one for dredging and the other for the construction of a part of the projected dike on the north side from the shore end outwards towards the light-house.

Under the contract for dredging, which closed July 5, 1889, the shoal on the inside opposite Freligh's wharf had been removed to a depth of 8½ feet, mean low water; a cut 50 feet wide and 7 to 8 feet deep, mean low water, had been excavated from the shoal in front of Sheffield's paper-mill, and a channel across the bar at the entrance had been opened 200 feet wide and 9 feet deep, mean low water. The total quantity of material removed was 28,746 cubic yards, resulting in the formation of a channel with an average width of 100 feet and 9 feet depth from the inner harbor eastward to the Hudson River. The inner harbor, for a length of 2,000 feet, has a channel 150 feet wide with a depth varying from 14½ to 20 feet, mean low water.

Under the contract for diking, which closed November 20, 1889, the north dike had been built out from the shore for a distance of 809½ feet the first 109½ feet being composed of crib-work covering a rocky ledge, and the next 700 feet of pile-work. The crib-work is 15 feet wide and the pile-work 7 feet wide, and both rise to a height of 2 feet above mean high water.

The width of the water-way between the north and south dikes, so far as constructed, is 260 feet. When the project is completed by the extension of the north dike 1,260 feet to the light-house, the width of the confined channel at the eastern end will be 325 feet.

In past years the channel at the entrance has shoaled up by reason of ice-gorges which formed at the mouth before the ice broke up in the Hudson. The shoals formed in this way have been partially removed by subsequent spring freshets. The purpose of the dikes is to contract the channel, to promote the scour of the freshets, and to maintain the

improved navigable depths during the low stage of summer, which usually lasts for two months, approximately.

As the direct result of the improvements which have been made by the Government, vessels with a draught of 12 feet and upward are now enabled to reach the factories at high tide.

The amount required to complete the improvement in accordance with the approved project is $20,000, and if this sum is appropriated it will be applied in extending the north dike to connect with the light-house pier, in dredging the two inner shoals, and in repairing the old constructions.

Saugerties is in the collection district of Albany, N. Y., which is the nearest port of entry. The nearest light-house is at the mouth of Esopus Creek.

COMMERCIAL STATISTICS.

The commercial carriers are five steam-boats for freight and passenger traffic, owned by the Saugerties and New York Steam-boat Company, the Saugerties and Albany Line, and the Saugerties, Rondout and Hudson Line, and four hundred and five sailing and other craft, the former carrying 17,000 passengers annually, and in all aggregate 189,000 tons of freight, valued at $5,484,000, the principal products being general merchandise, blue-stone, coal, and lumber.

The population of Saugerties is 5,000.

AMOUNTS APPROPRIATED.

July 5, 1884	$5,000.00
August 5, 1886	15,000.00
August 11, 1888	12,000.00
Total	32,000.00
Amount expended to June 30, 1890, inclusive of outstanding liabilities	31,278.07

Money statement.

July 1, 1889, amount available	$2,436.75
July 1, 1890, money value of work done during the fiscal year under contracts made prior to June 30, 1889	8,139.87
	10,576.62
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	9,854.69
July 1, 1890, balance available	721.93
Amount appropriated by act of September 19, 1890	10,000.00
Amount available for fiscal year ending June 30, 1891	10,721.93
Amount (estimated) required for completion of existing project	10,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	10,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

E 3.

IMPROVEMENT OF HARBOR AT RONDOUT, NEW YORK.

Rondout Harbor is formed by the mouth of Rondout Creek, which empties into the Hudson River on its west side, about 90 miles above the city of New York.

From the entrance to the lock of the Delaware and Hudson Canal, a distance of 3 miles, the creek is a tidal stream, the range of tides being 4 feet, approximately.

Prior to 1871 improvements had been made by private persons and corporations, but no permanent benefit had been derived from them. In 1869 a survey of the harbor was made by the Government with a view to its permanent improvement, and it was then found that the available depth of water in the channel was about 7 feet.

The project of improvement based upon this survey provided for the formation and maintenance of a channel 100 feet wide and 14 feet deep at the mouth of the creek, to be obtained by means of dredging and diking. Two parallel channel-dikes were to be built outward, toward, and into the Hudson River, their outer ends curving gently down-steam, while a branch dike, running up-stream along the Hudson from the outer end of the north dike, was to protect that dike from destruction from running ice. The estimated cost of the work was as follows:

Building the north dike, 748 yards long	$41,600
Building the branch dike, 640 yards long	34,400
Building the south dike, 1,277 yards long	59,600
Dredging a channel 3,000 feet long, 100 feet wide, and 14 feet deep at low water; 48,005 cubic yards, at 30 cents	14,400
Contingencies	22,500
Total	172,500

The final length of the north and south dikes was, however, to be determined after observing the effects which they might produce in the removal of the bar as they were gradually extended outward. The work was begun in 1872 and was completed in 1880. It was found by experience that the dikes might be shortened so much below the lengths originally deemed necessary for them that the total cost of the work was reduced to $101,000—less than two-thirds of the original estimate.

On the completion of the work, in 1880, the north dike was 2,200 feet, approximately, with a branch dike running up the Hudson 1,000 feet, approximately; and the south dike was 2,800 feet long, approximately, with a spur to the light-house 330 feet long. The distance between the dikes at the entrance was 350 feet, approximately. As the result of the works of improvement, there was a channel 50 feet wide, giving 13½ feet, mean low water; 100 feet wide, giving 12 feet, mean low water; and 200 feet wide, giving 10 feet, mean low water, from the creek to the channel of the Hudson. At the outer end of the dikes the distance between the 12-foot curves was over 300 feet.

The north and branch dikes were originally built to the height of mean high water, while the south dike, for 500 feet west of the light-house, was built only to the level of half-tide. The low part of the south dike was subsequently raised by crib-work to mean high water, but even with this increased height the dikes are submerged during storms, tides, and freshets, and are required to be marked by fender-piles to enable vessels to enter the harbor at such times without danger of being wrecked upon the concealed dikes.

The appropriations for this harbor, made since the completion of the works in 1880, have been applied exclusively to the repair of the dikes. The improved depths in the channel have been well maintained, but the dikes have greatly deteriorated, partly owing to the ice, partly to the natural decay of the timber, and partly to the undermining of the piles by scour.

A survey of the harbor was made in 1884, at which time the channel across the bar on the north side was 50 to 60 feet wide and 14 feet deep, mean low water, and the shoal on the south side had a least depth of 9.2 feet.

The last survey of the harbor, made in September, 1889, indicates a continued improvement of the channel between the dikes, not in the enlargement of the width of the 14-foot channel, but in that of the 9-foot channel, which now has a width of 250 feet.

On the south side of the entrance there has been a slight shoaling, due probably to the removal in 1884 of 150 feet from the outer end of the south pier, to meet the wishes of the boatmen, who alleged that their tows required a wider entrance between the piers on that side when coming in with vessels on the flood tide. The change in length of the south dike doubtless facilitates entrance at flood tide, but the shoaling of the bar on that side which is shown by the survey of 1889 makes it probable that the south dike should be increased rather than decreased in length.

The act of August 11, 1888, appropriated $5,000 for continuing the improvement.

The project of the application of this sum provided for the repair of all the dikes. Sealed proposals, invited by public advertisement June 21, 1889, were opened July 25, 1889, and the contract was awarded to Mr. Frederick J. Kelly, of Brooklyn, N. Y., the lowest bidder.

Operations under this contract were begun in September, and completed December 30, 1889. The autumn was unfavorable for work, as high winds and freshets prevailed to such a degree that during many weeks the contractor could employ no working force upon the improvement. The materials which had not been supplied on the expiration of the contract, November 30, were purchased in the open market at contract prices, and the work finally completed December 24. The repairs, though small in amount, were distributed over the entire dike system of both banks. Piles of the single-pile dike, south shore, west end, which had been raised by the ice were redriven to greater depths and properly secured; the damaged eastern end was removed and the stone filling placed in the central portion. Additional stone was placed in the dike at different points, and fender-piles were driven along the face to mark it during freshets. The north dike, at the junction with the branch, was strengthened by additional piles, the central portion was straightened and strengthened, and the channel-face for a distance of 900 feet, where undermining had occurred, was revetted with stone.

The following materials were used in the repairs:

White oak piles driven	linear feet	1,146.5
Pine piles driven	do	1,297.5
Waling timbers put on	B. M. feet	30,717.8
Tie rods	lbs	9,476.9
Drift bolts and washers	do	2,194
Ruble stone	cubic yards	1,500.1
Piles drawn		122
Piles redriven		65
Waling timbers removed	linear feet	252.6
Stone dredged and replaced	cubic yards	132.9
Piles driven back to position		15
Waling timbers removed and replaced	linear feet	474.5

The piers are now in fair condition, except that 1,000 cubic yards of stone are needed to give required security to the north, south, and branch dikes. A few minor repairs every year will be necessary to maintain the dikes.

The recommendation contained in the last annual report for the removal by dredging of the shoal on the south side of the entrance, and for the removal by dredging, or by blasting if necessary, of the inside shoals 1¾ miles from the light-house, is renewed in this report. The

inside shoals are great obstructions, and, lying close to the channel at a point where both banks are occupied with wharves, they materially restrict the facilities for vessels seeking berths alongside the wharves.

An appropriation of $25,000 is recommended for effecting these improvements, and for strengthening the dikes so as to render them permanent.

Rondout is in the collection district of New York. The nearest works of defense are those in New York Harbor.

COMMERCIAL STATISTICS.

The commercial statistics of this harbor have been carefully gathered and compiled, and show a total tonnage of 2,467,490 tons, valued at $41,268,850. General merchandise, coal, cement, lime, bluestone, and ice are the principal products handled, and are carried in about seven hundred vessels, which also carry 75,000 passengers annually.

Of the above tonnage, one-half passes through the Delaware and Hudson Canal, which connects the Hudson River at Rondout with the Delaware River at Port Jervis, N. Y., and with Honesdale, Pa., the heart of the Pennsylvania coal region.

The population of Rondout is 25,000.

AMOUNTS APPROPRIATED.

By act of Congress approved—	
June 12, 1872, diking	$10,000.00
March 3, 1873, diking	20,000.00
Amount allotted June 8, 1875, from repairs of harbors on Atlantic coast, repairs	762.18
From contingencies of rivers and harbors, etc., repairs	237.82
By act of Congress approved—	
August 14, 1876, diking and repairs	30,000.00
June 15, 1878, diking and dredging	30,000.00
By act of Congress passed August 12, 1882, repairs and dredging	2,000.00
By act of Congress approved—	
July 5, 1884, repairs and dredging	1,000.00
August 5, 1886, repairs	2,500.00
August 11, 1888, repairs	5,000.00
Total	101,500.00
Amount expended to June 30, 1890	101,500.00

Money statement.

July 1, 1889, amount available	$5,047.71
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	5,047.71
Amount appropriated by act of September 19, 1890	5,000.00
Amount (estimated) required for completion of existing project	20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	20,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for repairing dikes at Rondout Harbor, New York, received in response to the advertisement dated June 21, 1889, and opened July 25, 1889, by Lieut. Col. G. L. Gillespie, Corps of Engineers, U. S. Army.

	Frederick J. Kelly.*	
	Price per unit.	Total amount.
White-oak piles, 250 linear feet ..... linear foot..	$0.27	$67.50
Pine or spruce piles, 300 linear feet ..... do ...	1.12	36.00
Square timber, 30,000 feet B. M ..... M feet, B. M..	40.00	1,200.00
Tie-rods and screw-bolts, 8,000 pounds ..... pound..	.04	320.00
Drift-bolts, spikes, washers, chain, or cable, 660 pounds ..... do ...	.04	26.40
Rubble-stone for south dike embankment, 500 cubic yards ..... cubic yard..	1.00	500.00
Rubble-stone for revetment and refilling dikes, 1,000 cubic yards ..... do....	1.00	1,000.00
Outer end of south dike:		
Drawing 75 piles ..... each..	1.25	93.75
Redriving 15 piles ..... do....	.75	11.25
Walling timber, 16 linear feet ..... linear foot..	.32	5.12
Dredging and placing 100 cubic yards stone ..... cubic yard..	1.00	100.00
Western end of south dike:		
Driving 35 piles back to position ..... each..	.75	26.25
Taking off and replacing 100 linear feet of walling timber ..... linear foot..	.32	32.00
		3,418.27

* Only bid received.

E 4.

IMPROVEMENT OF THE HARLEM RIVER, NEW YORK.

The project for making a navigable water connection between the East River and the Hudson River by the way of the Harlem River and Spuyten Duyvil Creek was formulated upon the facts determined by the survey made along this route in 1874 in compliance with the river and harbor act of June 23, 1874, the report upon which may be found at page 224, Annual Report of the Chief of Engineers for 1875, Part II.

This report contains an interesting historical review of the navigation of the Harlem River from the Revolution to the present time.

A full history of this improvement as now adopted, with the legal proceedings for the acquirement of the land needed for it, and copies of the laws passed by the legislature of the State of New York relative thereto, is given in the annual report of the local engineer in charge to the Chief of Engineers for 1887. (See Annual Report of the chief of Engineers for 1887, Part I, pages 665 to 689.)

The streams embraced in the improvement are the Harlem River and the Spuyten Duyvil Creek, the former emptying into the East River near Hell Gate, and the latter into the Hudson River about 13 miles north of the Battery, and together separating Manhattan Island from the mainland.

There has always been an exchange of waters between these two streams at Kingsbridge, though a long ledge of rocks awash at mean low water and an extremely narrow channel at that point have heretofore prevented the exchange being a free one.

High Bridge is practically at the head of navigation in the Harlem River, but there is a fair channel of about 10 feet depth at mean low water as far as Morris Dock, 6 miles from the mouth of the river, and a crooked one of 7 feet depth to Fordham Landing, 1 mile further; but there is no navigation of this entire section, except by row-boats and a few boats loaded with material for the new Croton aqueduct or for the roadway of streets which are being opened in the "annexed district,"

Kingsbridge, 1¾ miles from the Hudson River, is the head of navigation in the Spuyten Duyvil Creek, but only at high water, for vessels drawing 8 feet.

The range of the tides in Harlem River varies from 5.5 feet at Third Avenue Bridge to 6 feet at the mouth of Dyckman's Creek, and in the Spuyten Duyvil Creek is 3.8 feet.

As the difference in the heights and times of tides between the East and Hudson rivers, after the connection is made between the Harlem and the Hudson rivers, will produce the currents upon which reliance is placed to keep the channel open, it is desirable that the cross-section of the channel be kept as uniform as possible, in order to avoid the unnecessary resistances to the flow of the water which would be caused by any contraction of the water-way.

The contraction of the proposed cut through Dyckman's Meadows will be more than counterbalanced by the natural channel through Spuyten Duyvil by the way of Kingsbridge, which is left open, and the contraction caused by the piers and embankments of the High Bridge, which carries the Croton Aqueduct across the Harlem River, should be counteracted by deepening the channels between the piers and abutments. Observations of the tides affecting these waters show that there is not a free exchange of tides between Harlem River and Spuyten Duyvil Creek, but that there is practically a divide somewhere near Fordham Bridge between the tides flowing from the East River into the Harlem River and from the Hudson River into Spuyten Duyvil Creek. Comparing the tides of the Harlem River at Fordham Bridge with those of the Hudson River at the mouth of Spuyten Duyvil Creek, it is found—

(1) That the level of mean high water in the Hudson is nearly 1 foot (.961 foot) lower than it is in the Harlem.

(2) That the mean rise and fall of the tide in the Hudson is 2.12 feet less than it is in the Harlem.

(3) That the mean duration of the rise of tides in the Hudson is thirty-six minutes shorter, the mean duration of the fall twenty-six minutes longer than in the Harlem.

(4) The mean level of the Hudson at the mouth of Spuyten Duyvil Creek is .265 of a foot lower than at Fordham Bridge.

(5) High water occurs one hour and thirty-four minutes earlier in the Hudson than in the Harlem.

From these facts it follows that while there will at different times be a flow towards either river, the preponderance of flow will be towards the Hudson, and the scour will go that way, so that if a cut for a free passage of the tides be made, the opening into the Hudson will become the mouth of the cut.

The project for the improvement was adopted in 1879. The proposed lines of improvement, as laid down by the engineer in charge in his annual report for 1882, are as follows:

(1) Below the Harlem or Third Avenue Bridge the outer pier and bulkhead lines as laid down by the park department are adopted.

(2) Above the Third Avenue Bridge to the entrance of Dyckman's Creek into the Harlem River, the exterior pier and bulkhead lines are laid down 400 feet apart.

(3) The line following Dyckman's Creek through Dyckman's Meadows will pass for a part of the way through solid rock, and it is here that the principal cost of the undertaking must be encountered. This part is to be made 350 feet wide. It would have been preferable to establish it at 400 feet, but the additional amount of rock excavation was the obstacle.

(4) The remainder of the line to the Hudson River will follow as nearly as possible the course of the Spuyten Duyvil, and the width will be 400 feet.

(5) The channel depth in the Harlem River and Spuyten Duyvil Creek will be 15 feet at mean low water, and in the channel along Dyckman's Creek 18 feet, mean low water.

The estimated cost of making the connection by a cut through Dyckman's Meadows, as given by General Newton in his report for 1882, is $2,100,000.

This estimate does not provide for the improvement of the channel of the Harlem River between this proposed cut and the mouth of the Harlem River.

The estimated cost of improving this part of the river, as given in General Newton's report for 1875, was about $600,000. Total for the improvement of the Harlem River between the Hudson River and East River, $2,700,000.

The project was revised in 1886 by narrowing the channel immediately north of High Bridge to 375 feet where it skirts the Ogden estate on the east bank. This change of width was approved by the Secretary of War October 7, 1886. (See Annual Report of the Chief of Engineers for 1887, Part I, page 671.)

The estimated cost of opening the channel from the Harlem River to the East by the way of the Harlem or Bronx Kills, making it 300 feet wide and 15 feet deep at low water, was about $2,200,000. This survey was ordered by act of Congress approved March 3, 1881, and the report upon it is to be found in the Annual Report of the Chief of Engineers for 1882, Part I, page 656.

After the legal difficulties for acquiring the right of way along the line of the proposed improvement were removed in May, 1887, the appropriations of 1878 and 1879, aggregating $400,000, became available for the execution of the project.

Work was begun, under the first contract, for earth and rock excavation along Dyckman's Creek, in January, 1888, and has continued uninterruptedly since that date.

The contract calls for the removal of 300,000 cubic yards of material, and up to the close of the present fiscal year the contractor has removed 124,311 of material above mean low water, and 140,201 below mean low water.

Under the river and harbor act of August 11, 1888, which made an appropriation of $70,000 for continuing the improvement, a second contract was made August 12, 1889, with the same contractor, after inviting sealed proposals according to law for the removal from Dyckman's Creek east of the site of the first contract of 71,000 cubic yards of earth and 19,000 cubic yards of rock, and for the building of an earthen and timber dam to shut out water from the Harlem River.

Operations were begun under the second contract in August, 1889, and at the close of the present fiscal year are still in progress.

On the 14th of May, 1890, Mr. Satterlee, the contractor, made an application for the extension of both contracts, and, by direction of the Chief of Engineers, the first contract has been extended to December 31, 1890, and the second contract to June 30, 1891. At the expiration of these limits it is expected that the work to be done under both contracts will be completed, as the plant is now in better condition than ever and the facilities for pushing the work are much improved.

On the completion of these contracts there will remain about 43,000

cubic yards of material to be removed to complete the improvement between the dams.

BRIDGES ACROSS THE HARLEM RIVER.

The site of the present Kingsbridge road where it crosses Dyckman's Creek, between the dams, has been designedly left undisturbed till the last moment, in order to give the city of New York time to prepare plans for the new bridge which will be required to be built at Broadway Crossing, to comply with the requirements of the State act of 1879 for new bridges. This matter was brought before the commissioner of public works, New York City, by this office in a letter dated March 22, 1889, but no action has as yet resulted therefrom.

The State of New York, anticipating the completion of the improvement, and desiring to co-operate with the General Government in maintaining the navigation of the Harlem River unimpaired after improvement, passed an act in 1879 which provides:

SEC. 10. The said consent is given and the said jurisdiction ceded upon the express reservation to the State of New York of concurrent jurisdiction with the United States in and over the territory covered by said improvement, so far as that all civil and criminal process which may issue under the laws or authority of the State of New York may be executed thereon in the same way and manner as if such consent had not been given or jurisdiction ceded, except so far as such process may affect the real or personal property of the United States: *Provided, however,* That the direction of the bridges hereafter to be constructed over said river or creek shall be at right angles to the courses of the improved channel, that the height of the bridges in the clear, at the draws, shall be not less than twenty-four feet above the high water of spring tides, and that the number and size of the bridge piers within the improved channel shall first be approved by the engineer of the United States in charge: *And provided further,* That no tunnel shall be constructed under said river or creek which will not permit of the excavation of a channel above it of at least twenty feet in depth at mean low water. There shall be constructed in every bridge, except in suspension bridges, hereafter built over said river or creek two draws contiguous to each other, and the length on the bridge occupied by the draw spans and the center pier separating them shall be at least two hundred and forty feet.

The bridges which have been built across the Harlem River since the passage of the act of 1879 are those at Second avenue, at Madison avenue, and the New York and Northern Railroad bridge at Eighth avenue.

During the past year the subject of raising the low bridges at Fourth and Third avenues has given rise to extended discussion, at home and abroad, among those in any way interested in the Harlem River or affected by its improvement, and an effort has been made to have those bridges reconstructed according to the State law of 1879 for new bridges.

The New York and Northern Railway Company and others interested in the navigation of the river, having heard that the park commissioners of New York City had under consideration the closing of the draws of all the bridges during certain stated hours every day, morning and evening, when the land travel over the bridges was greatest, united in a memorial, addressed to the Secretary of War, dated February 1, 1890, in which it was declared that the low bridges at Fourth and Third avenues were obstructions to the navigation of the river within the meaning and intent of sections 9 and 10 of the river and harbor act of August 11, 1888, and demanded that they be rebuilt.

Under instructions of the Secretary of War, three public hearings were given in May to the parties interested, but as they could not reconcile their differences, a Board of Engineers was convened May 7, 1890, to consider the whole subject, and to submit recommendations for adjusting the matters complained of.

The Board, after several adjourned meetings, beginning May 26, 1890, submitted its report on June 19, 1890.

The following table shows the location and characteristics of the several bridges across the Harlem River:

Name and location of bridge.	Width in clear in each draw.	Height of bottom chords above mean high water.	Remarks.
	Feet.	*Feet.*	
Second avenue	103.7	28.5	Double draw, railroad bridge, iron.
Third avenue	52.0	13.8	Double draw, road br dge, iron.
Fourth avenue	65.0	7.2	Double draw, railroad bridge, iron.
Madison avenue	132.0	28.0	Double draw, road bridge, iron.
McComb's Dam	80.0	36.7	Double draw, road bridge, wood and iron.
New York and Northern Railway bridge.	128.0	28.0	Double draw, railroad bridge, iron.
High Bridge (old Aqueduct)	.....	.....	No draw, width in clear between piers, 77.7 feet; intrados of arch, 100 feet above mean high water.
Washington Bridge, at One hundred and eighty-first street (single span).	.....	.....	No draw; iron arch; clear span, 500 feet; crown of arch, 136.7 feet above mean high water.
Foot Bridge, Fordham	24.7	3.9	Single draw; wooden trestle.
Farmers' Bridge	.....	3.1	No draw; two spans, 22 and 23 feet wide.
King's Bridge	.....	4.8	No draw; two spans, 18 and 25 feet wide.
Hudson River Railroad Bridge, mouth of Spuyten Duyvil Creek.	26.2	1.4	Single draw; wooden trestle.

The amount expended at the close of the fiscal year ending June 30, 1889, inclusive of outstanding liabilities, was $189,927.35.

WORK DONE DURING THE FISCAL YEAR.

Mr. Satterlee has continued work under both his contracts, without delays, excepting such as were occasioned by stormy weather, strikes of employés, and accidents.

Under the contract dated December 15, 1887, 111,539 cubic yards of material were removed during the year.

The following table shows the classification of the material and the amounts excavated each month during the year, and also the total amount removed up to date:

Period.	Above mean low water.	Below mean low water.	Total.
Prior to June 30, 1889	108,916	44,057	152,973
During July, 1889	1,782	6,884	8,666
During August, 1889	2,593	5,290	7,883
During September, 1889	6,437	6,368	12,805
During October, 1889	1,034	9,155	10,189
During November, 1889	1,099	7,949	9,048
During December, 1889	504	8,647	9,151
During January, 1890	647	9,947	10,594
During February, 1890	314	8,943	9,257
During March, 1890	187	6,627	6,184
During April, 1890	490	9,604	10,094
During May, 1890	217	8,077	8,294
During June, 1890	91	8,653	8,744
Total	124,311	140,201	264,512

All the rock excavated under this contract was stored on the grounds leased for that purpose, and most of the earth and clay was hauled away and used in the construction of the coffer-dam and temporary roadway east of Kingsbridge road.

Under the second contract with Mr. Satterlee, dated August 12, 1889, operations were begun immediately after the contract was signed on the construction of the coffer-dam, which was the first step necessary, as no material could be removed from the section of canal to be excavated under this contract until the site of the work was inclosed and the water pumped from it. But notwithstanding that the work was continued without prolonged interruption the dam was not completed until June, 1890. The dam consists of a line of sheet piling inclosed in an embankment of earth, clay, gravel, and stone constructed in a trench dredged across the marsh directly east of the easterly limit of the section of cut to be excavated, and crosses an arm of the Harlem known as Dyckman's Creek. The dam is 25 feet wide on top, and rises to 10 feet above mean low water, and will be so arranged that it may be used on the demolition of Kingsbridge Road Bridge as a highway until the city builds a new bridge where Broadway crosses the line of the canal.

The material underlying the marsh sod is of a very compressible nature, consisting mainly of the remains of an ancient vegetation nearly free from earthy matter. Except at the south end of the dam, where a stratum of hard sand and loam was met, this soft material extends down to the bed-rock, which underlies the site of the dam at a depth of from 45 to 55 feet below the surface. Owing to the compressible character of this material the settlement into it of the earth embankment forming the body of the dam was naturally very great, amounting in some places to over 17 feet below the depth to which the trench in which the dam is built was originally dredged, and consequently a somewhat greater amount of earth filling was required for the dam than was at first thought would be necessary. As this material was all supplied from the cut west of Kings-bridge Road and had to be carted over the narrow roadway leading through that work, and without interfering with the rock excavation there in progress, the amount that could be delivered in the dam daily was necessarily limited, and the construction of the dam could not proceed beyond a rate determined by these conditions; and it is mainly owing to these causes that the completion of the dam was delayed. The construction of the line of sheet-piling in the dam also required constant care and attention. Owing to the yielding nature of the material which the piles penetrated, they were liable to be forced out of place after being driven by the great and unequal settlement of the earth embankment surrounding them, and thus have their efficiency as a protection against leakage destroyed. This difficulty was overcome by building a central core of the embankment in the deepest portion of the excavated trench first and allowing it to settle thoroughly before driving any piles, then driving the piles along the outer edge of this core, and finally filling in the space on both sides of the piles, which then stood perfectly firm, as but little further movement could take place in the material surrounding them, being confined on the one side by the earth embankment already in place and on the other by the side of the excavated trench.

On the completion of the dam the removal of the material from the section of the cut to be excavated under the contract was begun, and at the close of the fiscal year 1,548 cubic yards of material had been ex-

cavated from the cut and 11,000 cubic yards had been dregded from the trench for the coffer-dam.

The general progress of the work was retarded to a considerable extent during the summer and autumn by rainy weather, but, on the other hand, the past winter was mild and without any heavy snow-storms, so that on the whole the year was not unfavorable for work and no prolonged delays were occasioned by the elements or other causes.

The coffer-dam at the westerly limit of the work, built by the contractor to keep out the waters of the Spuyten Duyvil Creek, in pursuance of the terms of his contract of December 15, 1887, has occasioned but little additional trouble. The large quantity of broken stone and earth thrown in behind the line of sheet-piling to repair the break in the dam has settled down into the marsh and become compacted to such a degree that it has finally reached a state of rest, and but little settlement has taken place during the past six months, and the leakage through the dam has been greatly reduced. A pit has been sunk in the northwesterly angle of the excavation low enough to drain the work thoroughly, and the little water which now comes into the cut either by leakage or surface drainage can easily be controlled by the pump available for this purpose.

As the result of the year's work, the excavation of the canal prism has been carried down to grade at the eastern end of the cut west of Kingsbridge Road for a length of 317 feet measured along the axis of the canal, and to nearly the full width of the channel, and at the western end for a length of 438 feet and width of 124 feet, giving a total area of 146,110 square feet where the excavation has reached grade—more than one-half the bottom area of the section of cut to be excavated under the contract of December 15, 1887. Over a large additional area the general level of the surface has been reduced to a plane but a few feet above grade.

The dam to the east of Kingsbridge road to keep out the waters of the Harlem River from the section of cut to be excavated under the contract of August 12, 1889, has been completed, the site of the work drained, and the removal of the material has been begun.

The amount that can be profitably expended upon the work during the next fiscal year is $1,000,000, and it can not be well or economically conducted unless the appropriations are large.

Harlem River is in the collection district of New York. The nearest light-house is on Blackwell's Island.

A full statement of the commerce likely to be benefited by the improvement is subjoined.

Mr. A. Doerflinger, assistant engineer, has been in local charge of this improvement during the year. He has remained constantly upon the work, and has discharged his duties with his accustomed fidelity and efficiency.

COMMERCIAL STATISTICS.

As there is no navigable communication between the Harlem River and Spuyten Duyvil Creek, the present navigation of the Harlem River is practically confined to that part of the stream between its junction with the East River and Fordham Heights Dock, a distance of about 7 miles.

Spuyten Duyvil Creek is navigable from its junction with the Hudson River to Kingsbridge, a distance of 1¾ miles.

The actual commerce of the Harlem River and Spuyten Duyvil Creek for the fiscal years ending June 30, 1889, and June 30, 1890, was as follows:

Items.	1889.	1890.	
	Tons.	*Tons.*	
General merchandise	1,250,516	1,379,334	$93,114,135
Grain, flour, etc	341,167	400,987	11,325,607
Lumber	292,500	346,858	5,866,283
Building material	535,766	642,922	2,297,600
Fuel	523,290	508,365	2,464,880
Ice	131,700	112,000	448,000
Total	3,093,939	3,384,466	115,506,425

The total tonnage for the year 1890 shows an increase over that of 1889 of 290,527 tons, or over 9 per cent.

The total tonnage for the year 1887 was given at 2,524,155 tons, showing an increase in the present tonnage over that of 1887 of 860,311 tons, or 34 per cent. in the three years.

Of the total tonnage for 1890, 1,407,882 tons were received at and shipped from the docks of the New York, New Haven and Hartford Railroad Company, directly below Second Avenue Bridge, and 246,402 tons were handled by the New York and Northern Railway Company at their docks near High Bridge. Of the balance, 1,709,632 tons were distributed among the various docks on the Harlem River between Ninety-second street and Fordham Heights, and 20,550 tons at various points on the Spuyten Duyvil Creek.

A large proportion of the freight handled at the railroad docks is carried in and out of the Harlem on railroad-car floats and transfer boats connecting the railroads of New Jersey and Pennsylvania terminating at Weehawken, Hoboken, and Jersey City with those of New England, while the general commerce of the river is carried on mainly in barges and canal-boats in tow of steam-tugs and in schooners and the smaller class of sailing-vessels.

AMOUNTS APPROPRIATED.

June 23, 1874, allotment from appropriations for East and Harlem Rivers	$11,000.00
By act of Congress approved:	
March 3, 1875	10,000.00
June 18, 1875	300,000.00
March 3, 1879	100,000.00
August 11, 1888	70,000.00
	491,000.00
Amount expended to June 30, 1890, inclusive of outstanding liabilities	367,060.22

Money statement.

July 1, 1889, amount available		$117,872.80
July 1, 1890, money value of work done during fiscal year under contracts made prior to June 30, 1889		122,960.07
		240,832.87
July 1, 1890, amount expended during fiscal year, exclusive of of liabilities outstanding July 1, 1889	$117,948.00	
July 1, 1890, outstanding liabilities	39,908.73	
July 1, 1890, amount covered by uncompleted contracts made during fiscal year ending June 30, 1890	62,401.33	
		220,258.06
July 1, 1890, balance available		20,574.81
Amount appropriated by act of September 19, 1890		250,000.00
Amount available for fiscal year ending June 30, 1891		270,574.81
Amount (estimated) required for completion of existing project		1,980,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892		1,000,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

E 5.

REMOVING OBSTRUCTIONS IN EAST RIVER AND HELL GATE, NEW YORK.

The East River is the name given to the narrow tidal strait which connects New York Harbor with Long Island Sound. It forms an entrance to the harbor of New York, secondary in importance only to the main entrance by way of Sandy Hook and the Narrows, since the heavy coasting trade carried on by New York with the New England States and the British American provinces passes almost exclusively through it.

The population now gathered around the waters of New York Harbor numbers nearly 3,000,000, and should the present rate of increase, as shown by the census returns, be maintained for half a century longer the population would then be about 8,000,000.

New York City can grow only in one direction, and that is into Westchester County, on the north, since on all other sides it is surrounded by water, and the development of the water-fronts along the Hudson and the East River must, therefore, be certain and rapid. With this development the importance of the East River entrance to New York Harbor will increase enormously, and within the next fifty years every foot of shore line on both sides of the East River, within 15 miles of Harlem River and Hell Gate, will be occupied with wharves filled with shipping, engaged not only in the coasting and transatlantic trade, but in the commerce of the world.

The East River is crooked and narrow in places, and much obstructed by rocks and affected by violent currents.

The worst of these obstructions is that known as Hell Gate, lying at the mouth of the Harlem River, between Blackwell's and Ward's islands, about opposite Ninety-sixth street, New York. Here the river turns at right angles around Hallet's Point, divides into several channels, and runs with a velocity varying at different stages of the tide from 3 to 10 miles an hour over or around Hallet's Point, Negro Point, Way's Reef, Shell Drake, Pot Rock, Frying Pan, Heel Tap, Holmes's Rock, Hog's Back, Flood Rock, Hen and Chickens, Gridiron, The Negro Heads, Mill Rocks, Rhinelander's Reef, and Bread and Cheese.

On account of the violence and irregularities of the currents and the crowded condition of this passage wrecks at Hell Gate were numerous prior to 1867. At that time some of these rocks projected above the water-level, while the least depth over others, at mean low water, varied from nothing to 20 feet. In obedience to the provisions of the act approved June 23, 1866, an examination was made of Hell Gate by the local engineer with the view of its improvement for purposes of navigation, and three separate projects were submitted January 21, 1867, for the improvement, affording channels of 26 and 24 feet in depth at mean low water. The project which was adopted in 1867 (see Annual Report of the Chief of Engineers for 1868, page 741) provided for the removal of the rocks and reefs that lay directly in the channel to a depth of 26 feet at mean low water; and for the building of sea-walls and dikes upon others that lay near the edges of the channel, in order to guide the currents in such a way that vessels might pass the reefs in safety. The cost of the project was estimated at $8,692,645.15. The removal of Hallet's Point was begun in 1869, and the final blast occurred September 24, 1876. A new estimate was made January 3, 1870, "based upon the process of tunneling the larger reefs, as Hallet's Point and

the Middle Reef, and removing the smaller reefs by drilling from the surface of the water," and the cost was placed at $4,689,820.

The steam-drill scow, fitted with a movable dome for submarine work, was first put in operation in the winter of 1870–'71.

The estimate was again revised in 1874 to include the removal of Diamond and Coenties reefs (see Annual Report of the Chief of Engineers for 1874, Part II, page 164) and the total cost fixed at $5,139,120. It provides for the removal at Hell Gate to a depth of 26 feet, mean low water, of the reef at Hallet's Point, Way's Reef, Shell Drake, Pot Rock, Frying Pan, Heel Tap, Negro Point, and Flood Rock, including the Gridiron, Hen and Chickens, and Negro Heads, and the construction of a dike to connect the Mill Rocks and sea-walls upon Hog's Back and Holmes's Rock; and in other parts of the East River for the removal of Diamond Reef and North Brothers Island Reef to a depth of 26 feet, Coenties Reef to a depth of 25½ feet, and the small rocks known as Scaly Rock, Blackwell's Rock, and the rock off Woolsey's Bath House.

The work of removal of Flood Rock began in June, 1875, and the great blast was fired October 15, 1885.

In 1880 the débris arising from the excavation of the galleries in Flood Rock was deposited partly in a dike to connect Great and Little Mill Rocks, and in 1882 a protection wall was built by the city authorities upon the reef at the head of Blackwell's Island known as Bread and Cheese.

The project was enlarged in 1884 to include the removal of Pilgrim Rock, off Nineteenth street, and again in 1889 to include the removal of the reef off Diamond Reef, reef off Thirty-third street, and Charlotte Rock, northwest of entrance to Newtown Creek, work to be done by hired labor with the drill-scow.

At the close of the fiscal year ending June 30, 1889, the following parts of this project had been executed: Hallet's Point, covering 3 acres, Way's Reef, Shell Drake, Diamond Reef, North Brothers Reef, Coenties Reef, and Scaly Rock had been removed to the depth contemplated in the project; Pilgrim Rock had been reduced to a least depth of 24 feet; Heel Tap had been broken to 26 feet and dredged to 20.5 feet, and the least depths on Frying Pan and Pot Rock were 18 feet and 22.8 feet at mean low water respectively; Flood Rock and connecting reefs, covering 9 acres, had been broken to 30 feet, and 85,095 tons of the débris had been removed; the Negro Heads and Hen and Chickens having been reduced to 18 feet mean low water, and a new 18-foot channel, 380 feet wide, opened across the reef. The total cost of this work was $3,709,457.64 up to June 30, 1889, including outstanding liabilities.

These results have been of the greatest value to navigation. The machinery and other plant stored at Astoria, as well as the drill-scow and other vessels moored at Mill Rock, have been kept in order during the year.

The expense of taking care of this property is considerable; it deteriorates to some extent with age, and much of it will be out of date if kept much longer. On the other hand, if sold at auction it will bring very little in proportion to what it would cost to replace it. It is apparent that a considerable saving to the United States would result from making the appropriations for this work large enought to admit of putting all this machinery at work before it ceases to be serviceable, without interrupting the work on Flood Rock, the removal of which is an immediate necessity.

The suit begun by private parties to dispossess the United States of its occupancy of the dike built by it between Great and Little Mill Rocks was decided by the courts in May, 1889, in favor of the United States, but appeal has been taken by the complainant to a higher court. It is highly important that the United States retain possession of the dike, as the ground is very much needed for wharfage and for repair shops for the steam-drill scow and the dredges. If the United States retains possession of this dike the machinery and other plant now stored at Astoria can be taken there, and the property in store will then be relieved of some of the charges for rent and watching.

Hell Gate, as has been said, is the worst obstruction found in the East River; but there are many other rocks and reefs in other parts of this crowded water-way which are constant sources of danger to passing vessels, which have often been complained of, and which ought to be removed. There is a long line of reefs and isolated rocks in mid-stream, extending a mile and a half downward from the foot of Blackwell's Island, which have always been troublesome to vessels beating up against the wind, or crossing from one channel to the other, as the winds and tides often compel them to do, and which, with the continually increasing size of vessels and the increasing commerce of the river, are becoming still more dangerous.

Another obstruction is the reef lying along the New York shore between Broome street and Twenty-third street. It is 8,300 feet long and 1,100 feet wide, and prohibits by its numerous shoal points the free use of the wharves on that front by deep-draught vessels. It was surveyed in August and September, 1889, to comply with the river and harbor act of August 11, 1888, and the report thereon was submitted January 24, 1890. The cost of removing the reef to a depth of 18 feet, mean low water, was estimated at $267,996, and to a depth of 26 feet, mean low water, at $4,042,718. Pilgrim Rock, which lies opposite Nineteenth street, and Shell Reef, opposite Tenth street, are prominent projections on this reef.

A still more serious obstruction to the navigation of the East River that is constantly complained of by mariners is Middle Ground, which is situated in mid-channel 1½ miles to the eastward of Hell Gate, near the southern entrance to Little Hell Gate, between Sunken Meadows and Lawrence's Point, with a channel on either side of barely 350 feet width. This reef is 1,350 feet long and 480 feet wide, and has a least depth of 11¼ feet, mean low water. It must not be confounded with "Middle Reef" of the estimates, which lay in Hell Gate proper. It is composed of hard sand, bowlders, and solid rock.

The Steamer *Puritan* ran upon the southern edge of this reef April 19, 1890, and was damaged to the extent of $24,500. It is estimated that the removal of the obstruction to a depth of 18 feet, mean low water, will cost $49,650. No estimate has been submitted before for the removal of this obstruction.

WORK DONE DURING THE FISCAL YEAR.

At the opening of the fiscal year two dredges owned by the United States were at work at Flood Rock removing the stone which had been broken up by the blast of 1885. They have been in commission throughout the year, except when temporarily withdrawn for repairs, on opposite sides of the reef, working east and west. They have not interfered with the free navigation of the river, as the channels to the northward and southward have afforded convenient passages for shipping. It is not

advisable, however, to increase the plant at this point, as it is preferable to defer the final completion of the work rather than overcrowd the channels with dredging plant.

During the fiscal year work has been carried on at Flood Rock, on reef off Diamond Reef, reef off Thirty-second street, and for a few days on Charlotte Rock.

Surveys have been made of reef off Thirty-third street; Charlotte Rock; of the Middle Ground opposite Sunken Meadows, Hell Gate; and of the reef between Broome street and Twenty-third street, New York shore.

Pier and bulk head lines were established by the Secretary of War on the west shore of the East River from the Battery to Eighty-first street, April 25, 1890, and on the east shore from Broadway Ferry, Brooklyn (E. D.), to Ravenswood, Long Island, February 8, 1890; from Fort Hamilton to Broadway Ferry, Brooklyn (E. D.), and from Ravenswood, Long Island to Lawrence's Point, Hell Gate, March 4, 1890.

FLOOD ROCK.

Work has been continued at Flood Rock by the two United States Engineer dredges, Nos. 5 and No. 6, throughout the year, with the exception of short periods when they were withdrawn for repairs, and No. 5 was engaged in assisting the drill scow. As the past winter was very mild, and no heavy ice was formed, the dredges were able to remain on the work the entire winter without withdrawing.

Dredge No. 5 was withdrawn from Flood Rock September 23, 1889, and worked from that date until November 27, 1889, on reef off Diamond reef and reef off Thirty-third street. On November 27 she resumed work at Flood Rock.

On April 1, 1890, Dredge No. 6 was withdrawn for general repairs, which were completed May 10, and she resumed work at Flood Rock May 12, 1890. The hull, ends, and sides were calked, sheathed, and painted, part of the deck has been renewed, and the entire deck recalked and painted. The engines and boiler have been overhauled and put in good order.

On May 5, 1890, Dredge No. 5 was withdrawn for general repairs, which were completed July 5, 1890. The hull, deck, and house have been painted, new gypsy-engines put in place, and new friction woods put in main friction. The boiler and engine were thoroughly overhauled and put in good order.

On March 12, 1890, tug *Ant* was withdrawn for general repairs, which were completed April 18. The hull was painted, and the copper sheathing repaired, a new wheel and shoe were put on, the deck was repaired and calked, the boiler and engine thoroughly overhauled, and a new air-pump was put in place.

These repairs put the entire plant employed at Flood Rock in good condition for some years, and it is thought only minor repairs will be required for some time to come.

The following table shows in detail the work done during the year:

Dredge.	Days worked	Hours worked.	Surface blasts fired.	Dynamite fired.	Rock removed.	Raised per day.
				Pounds.	*Tons.*	*Tons.*
No. 5	182	1317.9	65	3,310	16,271.19	89.4
No. 6	249	1826.6	141	10,340	31,127.80	125.2
Total	431	3144.5	206	13,650	47,398.99	.....

Total removed since explosion, October 15, 1885:

	Tons.
By contract	83,097
By hired labor, using Government plant	49,367
	132,464

The dredged rock has been dumped, as heretofore, in the deep hole off Eighty-ninth street, East River. This has not caused any perceptible decrease in depth, the soundings still ranging from 80 to 120 feet deep, mean low water.

The two dredges were worked on opposite ends of the reef—No. 6 on the eastern end, and No. 5 on the western end—keeping that part of the reef which is above low water between them as a protection against the strong current from at least one direction. The progress of the work compares favorably with the contractors' work, and is highly satisfactory. The work done has widened the 18-foot channel to 500 feet, and has reduced the area of the 26-foot curve materially.

UNITED STATES STEAM-DRILL SCOW.

Reef off Diamond Reef.—This reef consisted of two separate rocky projections above the 26-foot curve, having areas 10,000 square feet and 16,000 square feet, respectively, with a least depth of 23.3 feet and 20.8 feet, mean low water. It lies between the Battery and Brooklyn, and is about 150 yards northeast of the place occupied by Diamond Reef previous to its removal. The surface of the reef was covered with sand, gravel, and small bowlders which made the operation of dredging and blasting exceedingly difficult.

The United States steam-drill scow was moored on this reef July 8, 1889, began drilling July 10, and continued drilling and blasting until September 18, 1889, when she was taken to reef off Thirty-third street.

The United States engineer dredge No. 5 was moored on reef off Diamond Reef from September 23 to November 9, to raise the stone broken by the operations of the drill scow, and during this time raised 1,193.75 tons of broken stone.

On November 7, 1889, the drill scow returned to this reef to drill and blast the solid rock developed by the work of the dredge, and continued there until January 27, 1890, when operations were suspended on account of the low temperature of the water, and the drill scow was towed to her berth at Mill Rock, where the necessary repairs were begun to put her in good condition for another season's work. A centrifugal pump dredging outfit was purchased and put in place; a new mast and boom were adjusted; and the drill carriage and machinery were repaired.

On May 13, the drill scow resumed operations on the reef, and has continued at work until the close of the fiscal year.

On June 3, 1890, a dipper-dredge was hired for twelve hours for a trial to determine the practicability of relieving the drill scow from raising the broken stone by the slow and expensive process with divers. The result was not satisfactory, mainly because the dredge could not hold herself in the strong current, even with the assistance of the anchors of the drill scow.

Since the resumption of work on May 13, the divers have been engaged in raising the stone broken by drilling and blasting in September, 1889, using the centrifugal pump to clear the sand, gravel, and small broken stone from the larger fragments. The pump answers the pur-

pose admirably and enables the divers to do double the work previously accomplished, and with greater ease. On June 9, 1890, a large mass of solid rock that had not been drilled was uncovered by the pump, and drilling was resumed June 12.

The following table shows in detail the work done during the fiscal year ending June 30, 1890:

Number of times dome was lowered	44.00
Number of holes drilled	375.00
Total depth of holes drilled	2,514.30
Actual time running drills	277.80
Number of drill-hole blasts fired	43.00
Number of surface blasts fired	9.00
Pounds of explosive used (Forcite No. 2)	13,770.00
Tons of broken stone raised by divers	337.65
Tons of broken stone raised by dredge No. 5	1,193.75
Tons of broken stone raised by dipper-dredge	80.13
Tons of broken stone and sand raised by pump	132.38
Total tons raised and dumped	1,743.91

Reef off Thirty-third street and Charlotte Rock.—The surveys of reef off Thirty-third street and Charlotte Rock were made in July, 1889. These are two rocky reefs in the East River about opposite Thirty-third street, New York City. They are 1,000 feet and 1,900 feet, respectively, from the front of the dock at Thirty-third street, and divide the river (which is about 3,000 feet wide here) into three separate channels, each 1,000 feet wide. They are each approximately 200 feet long and 100 feet wide, and the least depth on Thirty-third Street Reef was 7.1 feet, and on Charlotte Rock 15.7 feet, mean low water.

The United State steam-drill scow was moored on Thirty-third Street Reef September 19, 1889, and began active operations for its removal. The surface of the reef being too jagged and uneven to afford a secure foundation to place the dome for drilling, surface-blasting was resorted to in order to reduce the high points, and the débris was removed by divers. As it was found that the rock was of such a nature as to break readily, the entire reef was covered with surface blasts, and the resulting broken stone was raised by United States engineer dredge No. 5.

The drill scow completed the surface-blasting on Thirty-third Street Reef November 4, and was then taken to Charlotte Rock, on which three surface blasts were fired; but, the result not being satisfactory, the drill scow, on November 7, returned to Reef off Diamond Reef and resumed work there.

On November 9, United States engineer dredge No. 5 was taken to Thirty-third Street Reef, and remained there until November 26, when the removal of the débris was completed, resulting in reducing the 26-foot area very much and making the least depth on the reef 19 feet, mean low water. Work will be resumed at this point sometime during the summer.

The following table shows in detail the work done on reef off Thirty-third street during the fiscal year:

Number of surface blasts fired	37.00
Pounds of explosive used (Forcite No. 2)	7,303.00
Tons of rock raised by divers	253.16
Tons of rock raised by dredge No. 5	1,230.64
Total tons raised and dumped	1,483.80
Cost per ton of rock excavated	3.84

CHARLOTTE ROCK.

Number of surface blasts	3.00
Pounds explosive used (Forcite No. 2)	916.00

The expenses incurred on account of the improvement during the year amount to $105,187.20, of which $9,570.05 remained outstanding at the close of the fiscal year.

The amount that can be profitably expended in the removal of obstructions in East River and Hell Gate during the next fiscal year is $500,000, to be applied to the removal of Flood Rock, to continuing the operations with the steam-drill scow, and to the removal of Shell Reef; of Middle Ground to 18 feet, and to the removal of such other rocks and reefs at other points in the channel as may be shown to be obstructive to navigation.

The work is in the collection district of New York. The nearest port of entry is New York City. The nearest light-house is Blackwell's Island Light. The nearest fort is Fort Columbus, Governor's Island, New York Harbor.

AMOUNTS APPROPRIATED.

By acts of Congress approved:		
July 25, 1868		$85,000.00
April 10, 1869		178,300.00
July 11, 1870		250,000.00
March 3, 1871		250,000.00
June 10, 1872		225,000.00
March 3, 1873		225,000.00
June 23, 1874		225,000.00
March 3, 1875		250,000.00
August 14, 1876		250,000.00
June 18, 1878		350,000.00
March 3, 1879		250,000.00
June 14, 1880		200,000.00
March 3, 1881		200,000.00
May 4, 1882		50,000.00
By act of Congress passed August 2, 1882		200,000.00
By act of Congress approved:		
July 5, 1884		360,000.00
August 5, 1886		112,500.00
By act passed August 11, 1888		250,000.00
Received from other sources		3,719.62
		3,914,519.62
Deduct amount reverted to U. S. Treasury	$3,158.55	
Deduct amount allotted to Harlem River	11,000.00	14,158.55
		3,900,361.07
Amount expended to June 30, 1890, inclusive of outstanding liabilities		3,814,644.84

Money statement.

July 1, 1889, amount available		$190,903.43
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$95,617.15	
July 1, 1890, outstanding liabilities	9,570.05	
		105,187.20
July 1, 1890, balance available		85,716.23
Amount appropriated by act of September 19, 1890		200,000.00
Amount available for fiscal year ending June 30, 1891		285,716.23
Amount (estimated) required for completion of existing project		1,038,840.67
Amount that can be profitably expended in fiscal year ending June 30, 1892		500,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

The registered tonnage, exclusive of coastwise vessels and local steamers, so far as it can be ascertained, is 10,165,325 tons.

The commerce of East River is so intimately connected with that belonging to New York Harbor proper, that it is impossible to make a separate statement for it.

The following list of vessels, not inclusive of daily passenger and freight steamers, passing through Hell Gate for the fiscal year ending June 30, 1890, has been compiled from the marine records at Whitestone, Long Island, kept by the New York Herald:

	Bound east.	Bound south.
Steamers	642	1,048
Ships	23	13
Barks	115	56
Brigs	80	61
Schooners	5,498	10,328
Tugs	680	682
Barges	2,612	2,862

E 6.

IMPROVEMENT OF NEWTOWN CREEK, NEW YORK.

Newtown Creek is a tidal stream about 4 miles long, running through the eastern part of Brooklyn and emptying into the East River opposite Thirty-fourth street, New York. The range of tides is 4½ feet, approximately, but the bed of the creek has no natural slope.

In 1857 it had a depth of about 17 feet, which had decreased in 1880 to about 12½ feet at low water, from its mouth up to the Vernon Avenue Bridge, a distance of 1,100 feet, its width for this distance being about 240 feet; thence it gradually decreased in width and depth until at the head of navigation, where the Metropolitan avenue crosses it, there was a low-water depth of about 4 feet and a width of about 100 feet.

A survey of this creek, with a view to its improvement, was made in 1879 by the engineer officer then in charge, to comply with the act of March 3, 1879, and a report submitted January 31, 1880. The project provided for dredging a channel from the mouth of the creek to Vernon Avenue Bridge, 200 feet wide and from 21 to 22 feet deep at low water, requiring the removal of 145,000 cubic yards of material, chiefly mud, the cost of which was estimated at $36,250.

Work under this project was begun in 1880, but by reason of increased cost of dredging the estimated cost was increased to $44,050.

Under the act of Congress passed August 2, 1882, another survey was made and a report submitted December 26, 1883 (Annual Report Chief of Engineers, 1884, page 765).

The new project provided for carrying the improvement from the Vernon Avenue Bridge up to the head of navigation in both branches of the creek. The estimated cost of executing this project was as follows:

To excavate a channel 18 feet deep and 175 feet wide, from Vernon Avenue Bridge to the Central Oil Works, 143,500 cubic yards excavation, at 30 cents	$43,050
Thence 15 feet deep, and from 125 to 150 feet wide, to Queens County Oil Works, 101,600 cubic yards excavation, at 35 cents per cubic yard	35,560
Thence 12 feet deep, and 125 to 150 feet wide, to Nichols' Chemical Works, 52,600 cubic yards excavation, at 40 cents per cubic yard	21,040
Thence 10 feet deep, and from 100 to 125 feet wide, to the head of navigation on both branches, 231,600 cubic yards excavation, at 40 cents per cubic yard	92,640
Contingencies	19,229
To which must be added the revised estimate for work below Vernon Avenue Bridge, before given	44,050
Total estimated cost of improving Newtown Creek	255,569

Up to June 30, 1886, $45,000 of this amount had been appropriated, and with it the channel below Vernon Avenue Bridge had been given a depth of 18 feet, with a width varying from 75 feet at the bridge to 150 feet at the mouth of the creek; and channels 10 feet deep and from 50 to 100 feet in width had been dredged from Covert's Dock up to the bridge at Metropolitan avenue and grand street on the west branch, and to Grand Street Bridge on the east branch, the distance being about 3,000 and 1,000 feet, respectively.

The act of Congress approved August 5, 1886, appropriated $37,500 for the improvement, but directed that $9,375 should be expended on the west branch between Maspeth avenue (Covert's Dock) and what is called the Dual Bridge at Grand Street and Metropolitan avenue; $9,375 on the main branch between easterly Grand Street Bridge and Metropolitan avenue, and the balance on the lower end, from Maspeth avenue to the mouth.

Work under this act was completed by contract September 12, 1887. Seventy-thousand cubic yards of material were excavated between East River and Vernon Avenue Bridge, resulting in a channel 18 feet deep, mean low water, with a width varying from 200 feet at the entrance to 140 feet at the bridge.

Twenty-five thousand one hundred and seventy-five cubic yards were removed from the easterly branch between Grand Street and Metropolitan Avenue Bridge, giving a channel 100 to 125 feet wide and 8½ to 10 feet deep, mean low water; and 25,071 cubic yards were removed from the westerly branch between Maspeth Avenue and Dual Bridge, giving a channel of the same width and depth as on the eastern branch.

From the foregoing statements it will be observed that the amount appropriated up to and inclusive of act of August 5, 1886, was $82,500, of which amount the sum of $50,750 has been applied from Vernon Avenue Bridge to the East River, and $31,750 from Covert's Dock, upstream, to the head of navigation on both branches. These appropriations were made in small amounts and at wide intervals, and the work done by them gave only temporary relief. According to these methods the amounts applicable for improvement at the entrance were about sufficient to remove deposits which had been made during the interval, leaving no balance for increasing the depth beyond 20 feet; the improvement could not be extended to benefit the central reach of the river above Vernon Avenue Bridge, and, in the absence of secure bulkheads, dredging in the upper branches was of little avail. It would have been better had appropriations been made in such a way that the improvement above Vernon Avenue Bridge could have been executed as an extension of the improvement below it. Then as the improvement advanced up-stream the wharves along the banks would have been benefited progressively and in proportion to their importance.

A revised estimate for the improvement was made in 1889 (Annual Report, Chief of Engineers, 1889, Part I, page 778), after the results obtained by the survey of January, 1889, had been studied, and the cost was fixed at $170,586.

In preparing the new project for the improvement it was kept in mind that the draught of vessels going above Vernon Avenue Bridge, where the most important wharves are located, was limited by the then available depth of water, and that many of the vessels had to be lightered at the bar to facilitate entrance at high tide, while those going out had to complete their cargoes after they reached the East River. It was therefore thought best to provide for 21 feet from the entrance to Vernon Avenue Bridge, 18 feet to Central Oil Works, 15 feet to Queen's

County Oil-Works, 12 feet to Nichols's Chemical Works, and 10 feet to Metropolitan Avenue Bridge, on both branches.

The bed of the creek below Vernon Avenue Bridge is variable below the plane of 18 feet, mean low water; near the bar it is composed of sand, or sand and clay mixed, but as the bridge is approached it grows harder like hardpan, and has large bowlders imbedded in it. The creek is the receptacle for all the refuse from the sewers, factories, slaughter-houses, and oil-refineries of the east of Brooklyn; constant deposits are therefore forming in it, especially at the upper end, from these causes and from the caving in of the unprotected banks, which consist of marsh mud. To remedy this difficulty, annual dredging will be needed until the banks are protected by bulkheads throughout their whole length.

From the information gained during the year in regard to the necessities of this stream, it is believed that the depth from the entrance to Vernon Avenue Bridge may properly be increased to 23 feet, mean low water; thence to Penny Bridge to 20 feet; and thence to Metropolitan avenue, 12 feet.

WORK DURING THE FISCAL YEAR.

At the opening of the fiscal year an agreement was in force with Mr. James A. Simmons, by authority of the Secretary of War dated February 11, 1889, for the removal of 120,000 cubic yards of material towards the improvement of the creek from the entrance to Queens County Oil-Works, as follows:

	Cubic yards.
For opening a channel 100 feet wide and 21 feet deep from Vernon Avenue Bridge to East River	50,000
For opening a channel 75 feet wide and 18 feet deep from Vernon Avenue Bridge to Central Oil-Works	60,000
Removing middle ground opposite Queen's County Oil-Works to a depth of 10 feet	10,000

This agreement expired January 1, 1890, but was extended to October 1,1890, by authority of the Chief of Engineers dated December 17, 1889.

Work under this agreement has been in progress throughout the fiscal year. The quantity allotted to the reach from Vernon Avenue Bridge to the Central Oil-Works, 60,000 cubic yards, was removed by February 1, 1890, and resulted in a channel 80 feet wide and 18 feet deep, mean low water. The middle ground opposite the Queens County Oil-Works was dredged to 10 feet, mean low water, by March 11, 1890, and since that date the dredge has been employed below the Vernon Avenue Bridge, where the channel at the present date is 60 feet wide and 21 feet deep, mean low water.

The quantity of material removed during the fiscal year is 83,850 cubic yards, and the total amount removed under the agreement is 91,588 cubic yards.

Three wrecks were found in the channel above Vernon Avenue Bridge, and were removed by the Atlantic Dredging Company at an approved expense of $700.

Several bowlders uncovered by the work of the dredge have been blasted and removed.

The influence of the work done under the present appropriation is very marked, and the appreciation of it is shown by the fact that some

of the shore-owners are dredging the spaces in front of their wharves to from 21 to 25 feet, mean low water.

No work has been done from Maspeth Avenue up both branches of the creek since September 12, 1887. At that date the channel in both branches was from 100 to 125 feet wide, and from 8½ to 10 feet deep. A resurvey made in January, 1889, showed that these channels had continued to shoal, reducing the available depth to 6.5 to 7 feet, mean low water.

Harbor-lines for Newtown Creek, from the mouth to Whale Creek, were established by the Secretary of War February 8, 1890.

An appropriation of $100,000 is recommended for continuing the improvement.

This work is in the collection district of New York. Nearest port of entry, New York City. Nearest light-house, Blackwell's Island Light. Nearest fort, Fort Columbus.

Amounts appropriated.

Date.	Application.	Amount.
June 14, 1880	Dredging below Vernon Avenue Bridge	$10,000
Aug. 2, 1882	....do	15,000
July 5, 1884	Part applied above Vernon Avenue Bridge	20,000
Aug. 5, 1886	Below and above Vernon Avenue Bridge	37,500
Aug. 11, 1888	Newton Creek and Bay	25,000
Total		107,500

Amount expended to June 30, 1890, inclusive of outstanding liabilities, $101,965.52.

Money statement.

July 1, 1889, amount available		$2,816.56
July 1, 1890, money value of work done during the fiscal year under contracts made prior to June 30, 1889		15,512.28
		18,328.84
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$16,312.05	
July 1, 1890, outstanding liabilities	1,738.50	
		18,050.55
July 1, 1890, balance available		278.29
Amount appropriated by act of September 19, 1890		35,000.00
Amount available for fiscal year ending June 30, 1891		35,278.29

Amount (estimated) required for completion of existing project	113,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	100,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Imports and exports.

Articles.		Amount.		Value.
		Imported.	Exported.	
Lumber	feet, B. M.	263,040,852	21,000,000	$5,936,994
Coal	tons	440,410		1,652,784
Oil	cases		2,937,273	2,900,000
	gallons	19,949,255	29,252,557	3,026,569
Residuum	do	20,093,200	1,378,148	623,436
Grain	bushels	140,000		140,000
Brick		125,000,000		650,000
Lime and cement	barrels	260,000		260,000
Stone and sand	tons	105,000		107,000
Chalk	do	20,000		70,000
Tin, lead, iron, and steel	do	9,776	500	985,791
Oil of vitriol	pounds	20,457,437		135,840
Jute, hemp, manila, etc	tons	200,000		2,000,000
Empty barrels and cases		577,058	1,036	460,033
Naphtha	gallons		6,464,226	381,963
Candles and wax	pounds		11,765,064	539,506
Separated acid	gallons		1,035,695	19,366
Miscellaneous	tons		24,075	2,236,521
Total				22,045,745

Vessels arriving and departing.

Class.	Number.	Tonnage.
Steamers	12	15,240
Ships	26	31,200
Barks	125	87,500
Brigs	13	10,400
Schooners	2,226	1,112,000
Lighters	1,022	204,400
Barges	2,783	556,400
Canal-boats	3,068	306,800
Total	9,274	2,324,940

There were built on Newtown Creek 23 new vessels, 7,200 tons capacity, and valued at $265,000.

E 7.

IMPROVEMENT OF BUTTERMILK CHANNEL, NEW YORK.

Buttermilk Channel is the name given to the channel which separates Governor's Island, at the mouth of East River, New York Harbor, from the city of Brooklyn, which lies east of it.

The channel on the northwest side of Governor's Island, which separates it from the lower end of the city of New York, is the wider and deeper of the two, and is the channel most used by vessels passing between the East River and other parts of New York Harbor.

Buttermilk Channel is obstructed by three shoals:

1. A shoal lying above and northeast of Governor's Island, projecting into Buttermilk Channel and extending over to the main channel on the other side, which originally had a least depth over it of 9½ feet at mean low water.

2. A shoal putting out from Red Hook Point, on the Brooklyn side, and extending up to the eastern side of the channel to the entrance of

the Atlantic Basin, with a least depth on it of about 5 feet at mean low water.

3. A shoal putting out from the southern side of Governor's Island and extending towards the Red Hook Point shoal, which is partly dry at mean low water.

Between the first-mentioned shoal and Governor's Island is a narrow channel with 30 feet of water in it, and between this shoal and the Brooklyn shore there is a channel of the same depth, also originally narrow, but widened now to about 900 feet.

A narrow and crooked channel about 30 feet deep lies between the two latter shoals.

The line of docks and wharves from the Brooklyn Bridge down to the mouth of the Atlantic Basin on the Brooklyn side is one of the most important in the New York Harbor, and this part of the river, extending from the Brooklyn Bridge to Governor's Island, is regarded by pilots and masters of vessels as one of the most difficult places in New York waters to carry a vessel through safely, on account of this shoal, the rapid current, and the enormous traffic passing, not only up and down, but across the stream.

Tows, tugs, small steamers, and small craft generally in passing up and down this part of the East River keep to the New York side, forcing the larger class of Sound steamers, ocean steamers, and sea-going ships in tow of tugs to keep over towards the shoal at the upper point of Governor's Island, and if, as is often the case, these vessels are obliged to stop in order to avoid collision with ferry-boats, sloops, and canal-boat tows, they are liable to drift upon this shoal.

Upon a statement of these difficulties, made by shipping merchants and others whose business lay along the Brooklyn wharves between Wall Street Ferry and the Atlantic Basin, a survey of this shoal was ordered in 1872, and a project for its improvement was adopted in 1880.

This provided for the removal, to the depth of 26 feet, at mean low water, of such parts of this shoal as lay within 850 feet of the line of the Brooklyn wharves.

The estimated cost of this improvement was $210,000. Up to June 30, 1886, $180,000 were appropriated for improvements, by the expenditure of which 466,276 cubic yards of material were removed, deepening the water in the channel between the shoals and Brooklyn to 22-24 feet, mean low water, over a width of 850 feet. The part removed included the original crest of the shoal, leaving no part of it on which there was less than 17 feet, mean low water. In the annual report for 1885 it was recommended that the channel on the east side be widened from 850 feet to 1,150 feet, unless it should be decided to remove the whole shoal to a depth of 26 feet, mean low water, for which the estimate of $170,000 was given.

The act of August 5, 1886, appropriating $56,350, practically approved the project for removing the whole shoal, since this appropriation was larger than the amount recommended for widening the channel only.

The improvement by dredging was continued under contract in 1887, and the depth of water over the shoal was increased to 22 feet, mean low water, except in a few isolated spots where the depth varied from 17 to 19 feet.

The act of August 11, 1888, appropriated $100,000, for continuing the improvement. A detailed survey of the shoal was made in July and August, 1888, and it was estimated by the officer in charge that the entire removal of the shoal to 26 feet, including the deposits, natural and artificial, which had been made since the work began, would require the dredging of about *425,000* cubic yards.

WORK DURING THE FISCAL YEAR.

At the opening of the fiscal year, a contract was in force with Mr. James A. Simmons, of New York, for the removal of 500,000 cubic yards of material from the shoal. This quantity, it was believed, was ample to provide against all contingencies of illicit dumpings and shoalings from natural causes to which the locality is subject, and to give a full depth of 26 feet, mean low water, everywhere over the shoal.

It was not till the 10th of November that the dredging plant of the contractor was ready for work. The dredge is of the type popularly known as the "ladder dredge," which has been extensively used upon the Panama Canal. Although not designed originally for use in tidal waterways where strong currents prevail, it makes a very uniform bottom, and the monthly progress, while not equal to the expectations of the contractor, has been generally satisfactory. In practice it makes a cut 100 feet wide, carried down to the specified grade.

This work is in progress at the close of the fiscal year. The amount dredged during the year is 206,199 cubic yards. Under the present contract a depth of 26 feet, mean low water, has been obtained over the south end of the shoal for a distance of 500 feet, approximately, along the axis, and a cut, 450 feet wide, has been carried north and south through the entire length of the shoal, together with a second cut 100 feet wide for one-half the length of the shoal.

It is quite probable that the strict manner in which existing laws in regard to dumping have been carried out during the past year will so reduce the quantity of illicit dumping on this shoal, for which allowance has been made in the estimates for dredging, that material will not be found in the main shoal equal to the contract quantity. In that case, the balance will be applied at Red Hook Point, in the same channel, a short distance to the southward and westward. It is estimated that to increase the depth to 26 feet over the entire point, which lies in advance of established harbor-lines, will require the removal of 1,681,439 cubic yards. Until a careful survey is made the estimate of cost can be given only approximately; it is thought, however, that the cost will not vary greatly from $350,000. On the completion of the existing contract, and the removal of the Red Hook Point shoal, Buttermilk Channel will be entirely free from obstruction down to the depth of 26 feet, mean low water.

An appropriation of $200,000 is asked to complete the improvement.

Harbor-lines for the Brooklyn shore were established by the Secretary of War, March 4, 1890.

This work is in the collection district of New York. The nearest port of entry is New York City, and the nearest work of defense Fort Columbus, New York Harbor. The nearest light-house is Robbins' Reef.

Amounts appropriated.

Date.	Application.	Amount.
June 4, 1880	Dredging	$60,000
Mar. 3, 1881	....do	60,000
Aug. 2, 1882	....do	60,000
July 5, 1884	....do	10,000
Aug. 5, 1886	....do	56,250
Aug. 11, 1888	....do	100,000
	Total	346,250
	Received from other sources	100
		346,350

Amount expended to June 30, 1890, inclusive of outstanding liabilities, $281,612.15.

Money statement.

July 1, 1889, amount available		$12,340.99
July 1, 1890, money value of work done during fiscal year under contracts made prior to June 30, 1889		38,146.84
		50,487.83
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$31,470.95	
July 1, 1890, outstanding liabilities	8,632.19	
		40,103.14
July 1, 1890, balance available		10,384.69
Amount that can be profitably expended in fiscal year ending June 30, 1892 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867		200,000.00

COMMERCIAL STATISTICS.

The commerce of Buttermilk Channel is so intimately connected with that of New York Harbor that it is impracticable to determine the amount and value.

The number and tonnage of vessels loading and unloading at the Brooklyn wharves, immediately fronting on Buttermilk Channel, during the fiscal year ending June 30, 1890, as shown by the Maritime Register, is as follows:

Vessels arriving and departing.

Class.	Number.	Tonnage.
Steamers	1,047	1,430,192
Ships	253	389,996
Barks	1,632	783,360
Brigs	312	99,600
Schooners	714	214,200
Total	3,958	2,917,348

This does not include the numerous lighters and canal-boats of which no record is kept.

E 8.

IMPROVEMENT OF GOWANUS BAY, NEW YORK.

Gowanus Bay is a part of New York Harbor, lying at the mouth of Gowanus Creek, in the southwestern part of the city of Brooklyn. The depth of water in the channel was formerly 7 to 12 feet at mean low water, which was wholly insufficient for the passage of the vessels employed in the commerce of the district. A survey of Gowanus Bay and Creek was made in 1880, and a project for their improvement was submitted in January, 1881.

This project provided for dredging a channel between the pier lines established by the commissioners appointed by the State of New York in 1875, beginning at the bay and extending up the creek to Hamilton Avenue Bridge, 18 feet deep at mean low water, and 200 feet wide, except for the upper few hundred feet near the bridge, where the width was to be gradually reduced from 200 feet to 100 feet.

The total length of the proposed channel was about 9,000 feet.

The estimated cost of this improvement was as follows:

530,000 cubic yards of dredging, at 30 cents per cubic yard	$159,000
Contingencies	23,850
Total	182,850

The proposed channel, however, did not follow the old channel at the mouth of the creek, since the pier line established by the commission crossed the old channel at that point, and the land under water inside of it, including the bed of the old channel, had become private property.

The owners of this property, Messrs. Beard & Robinson, were anxious, nevertheless, to have the old channel improved instead of having the new one formed, as proposed, outside of the established pier line; but as this could not be done, they surrendered their right to build out to the pier line; they signed a paper relinquishing their right to build piers which should obstruct the old channel so long as that channel should be permitted to exist, and the Maritime Association of New York at the same time petitioned that the old channel should be kept open. As the improvement of this channel would, however, help only the land near it on the north side, and not at all that which lay on the opposite or southerly side of the creek, the local officer recommended that the conflict of interests be settled by dredging the natural channel from the Hamilton Avenue Bridge down to the southwest corner of the Erie Basin; and that from that point two channels should be dredged—one running northerly along the west side of the Erie Basin to deep water near Red Hook, and the other running southerly along the wharves on the south side of the bay towards Bay Ridge.

Both of these channels were to be 200 feet wide and 18 feet deep at mean low water.

This project required for its execution a larger amount of work than the original scheme called for, namely:

The excavation of 583,530 cubic yards of material, which, at 30 cents per cubic yard, would cost	$175,059.00
Contingencies, 10 per cent	17,505.90
Total	192,564.90

The legal measures necessary for securing the right of way across Beard & Robinson's property at the mouth of the creek were not completed satisfactorily until May, 1883, but under appropriations of 1881, 1882, and 1884 the proposed Red Hook branch of the channel was dredged 100 feet wide for a length of 2,000 feet, measured from Red Hook, and the southern channel, running towards Bay Ridge, was begun at the southern end and carried northward for a distance of 1,900 feet, with depths in it varying from 21 to 17 feet, except for a few hundred feet at the upper end on the eastern side, where the last cut was left unfinished.

The act of Congress approved August 5, 1886, appropriated $7,500 for continuing the improvement. The funds were applied by contract in 1887 in making a cut 1,500 feet long, 40 feet wide, and 18 feet deep mean low water along the northern channel line of the creek from a point opposite the foot of Twenty-third street to one opposite the foot of Sixteenth street, Brooklyn. The overlying mud ran into the dredged channel so readily that when the contract was closed March 12, 1887, the cut was 40 feet wide at the bottom and from 55 to 75 feet wide at

the top, with a depth of only 15 feet. At that date the condition of the improvement in Gowanus Bay and Creek was as follows:

What may be called the Red Hook Channel, running round the Erie Basin to the mouth of the creek, had been practically completed for its full width and depth, and the channel leading from it up the creek had been completed to within 2,100 feet of Hamilton Avenue Bridge, with a farther extension of 15 feet deep and 40 feet wide at bottom for 1,500 feet farther up the creek.

What may be termed the Bay Ridge Channel, south of the mouth of the creek, had been begun at its outer or southern end, and had been carried up with nearly full depth and width to a point 2,000 feet south of the mouth of the creek.

The following work then remained to be done to complete the project:

The completion of the channel up the creek 2,100 feet to the Hamilton Avenue Bridge, and the extension of the southern or Bay Ridge Channel northward, so as to connect with the Red Hook Channel at the mouth of the creek.

A sketch of the work, June 30, 1885, may be found in the Annual Report Chief of Engineers for that year, Part I, page 672.

Under the estimates of $192,564.90 only $72,500 had been appropriated to June 30, 1887.

In the Annual Report for 1888, page 615, the local officer states that the dimensions previously adopted for the two channels are too small in view of the great increase in length and draught which had taken place lately in the construction of sea-going vessels, especially steamers, and recommended that the depth of these channels should be increased to 21 feet mean low water and their width to 400 feet, while to facilitate the handling of vessels in the contracted space near the mouth of Gowanus Creek more room should be gained by cutting away the angle on the south side.

It was estimated that to make these changes in the channel would involve the removal of 1,345,000 cubic yards of material measured in place, as follows:

	Cubic yards.
Red Hook Channel:	
To deepen it to 21 feet	70,000
To widen it to 400 feet	100,006
	170,000
Bay Ridge Channel:	
To deepen it to 21 feet	250,000
To widen it to 400 feet	275,000
	525,000
Gowanus Creek Channel:	
To deepen it to 21 feet	350,000
To cut away at the angle	300,000
	650,000
Total in place	1,345,000
Which, at 40 cents per cubic yard, would cost	$538,000
Contingencies	62,000
Total	600 000

The river and harbor act of August 11, 1888, making appropriation for continuing the improvement, reads as follows:

Continuing improvement by dredging to 21 feet mean low water and widening the channel to 400 feet on the northerly side from the foot of Percival street along the wharves to the 23-foot curve opposite the entrance to Erie Basin, $60,000.

This provided for the commencement of the first and third parts of the project recommended in 1888. The required width of 400 feet at the entrance could not be obtained without dredging inside the pier and bulkhead line established by the State in 1875, and in the upper 3,000 feet of the creek could not be made 400 feet wide without interfering with the vested rights of property on the west side to such a degree as to practically prohibit the execution of the project. The project which was accordingly adopted for the application of the appropriation provided that the channel to be ultimately dredged should be 400 feet wide from the entrance to the eastern end of the Erie Basin, and carried thence 250 feet wide to the foot of Percival street, where provision would be made again for widening the channel by dredging out the three triangular spaces or slips on the north side immediately below that street.

WORK DONE DURING THE FISCAL YEAR.

At the opening of the fiscal year a contract was in force with Mr. James A. Simmons, dated February 27, 1889, for the removal of 300,000 cubic yards of material for the improvement of the Red Hook Channel.

This contract expired January 1, 1890, but was extended to October 1, 1890, by authority of the Chief of Engineers, dated December 17, 1889.

Work under this contract was continued throughout the year, except during the months of September and October, and part of November and December, when the dredge employed here was engaged on the Raritan Bay contract. The quantity removed during the fiscal year is 135,967 cubic yards, and the total removed under the contract is 174,905 cubic yards.

At the close of the fiscal year the channel from the entrance to Erie Basin to the foot of Percival street is about 75 feet wide and from 19 to 21 feet deep, mean low water, and the triangular slip at the foot of Bryant street has been dredged to 21 feet, mean low water. No work has been done on the Bay Ridge Channel since January 16, 1884, at which date this channel was 200 feet wide and 18 feet deep, mean low water, and its northern terminus was separated from the Red Hook Channel by a distance of 2,000 feet, over which the least depth did not exceed 10 feet.

The establishment by the Government of harbor-lines on the south side of the bay has given confidence to riparian owners on that shore, and it is expected that deeper water than now exists along the pierhead line will be required to meet the demands of commerce, which is already giving evidences of important increase in the near future.

Harbor-lines for Gowanus Bay and for Gowanus Creek to the Hamilton Avenue Bridge were established by the Secretary of War March 4, 1890.

An appropriation of $150,000 is recommended for continuing the improvement of both channels.

Gowanus Bay is in the collection district of New York City; nearest light, Robbins' Reef; nearest work of defense, the fort on Governor's Island, 1 mile to the northward.

Amounts appropriated.

Date.	Application.	Amount.
Mar. 3, 1881	Dredging	$40,000
Aug. 2, 1882	....do	20,000
July 5, 1884	....do	5,000
Aug. 5, 1886	....do	7,500
Aug. 11, 1888	....do	60,000
	Total	132,500

Amount expended to June 30, 1890, inclusive of outstanding liabilities, $107,430.42.

Money statement.

July 1, 1889, amount available		$3,528.52
July 1, 1890, money value of work done during fiscal year under contracts made prior to June 30, 1889		25,153.91
		28,682.43
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$22,113.58	
July 1, 1890, outstanding liabilities	4,641.83	
		26,755.41
July 1, 1890, balance available		1,927.02
Amount appropriated by act of September 19, 1890		60,000.00
Amount available for fiscal year ending June 30, 1891		61,927.02
Amount (estimated) required for completion of existing project		480,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892		150,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

[For the year ending December 31, 1889.]

Receipts and shipments.

Articles.	Quantity.	Value.
Coal ... tons	687,000	$2,748,000
Brick ... number	202,000,000	1,414,000
Lumber ... feet, B. M.	147,000,000	2,940,000
Lime, etc ... barrels	460,000	690,000
Grain ... bushels	2,750,000	1,100,000
Ice ... tons	230,000	805,000
Roofing tar ... barrels	75,000	225,000
Building stone, etc		647,000
Miscellaneous		2,500,000
Total		13,069,000

Vessels arriving and departing below Hamilton Avenue Bridge.

Class.	Number.	Tonnage.
Steamers	46	33,211
Ships	68	105,741
Barks	439	441,614
Brigs	56	17,627
Schooners	281	57,392
Total	890	655,585

Vessels arriving and departing above Hamilton Avenue Bridge (record of bridge tender).

	Times opened and closed.	Vessels passed through.	Registered tonnage.	Daily average of times opened.
June 1, 1889, to May 31, 1890	8,624	7,668	1,430,664	23
1886	7,632	6,071	985,431	21
Increase	992	1,597	445,233	7

Classification of vessels.

	Number.	Registered tonnage.	Draught.
			Feet.
Schooners	1,393	172,738	6 to 12
Sloops	972	62,925	6 to 10
Barges	1,625	409,486	6 to 8
Canal-boats	3,678	785,516	6 to 8
Total	7,668	1,430,664	.....

The increase in value of receipts and shipments, compared with 1887, is $749,000. It is believed that the values as stated in 1887 are too large, and that the true increase is very much larger.

E 9.

IMPROVEMENT OF NEW YORK HARBOR, NEW YORK.

New York Harbor is the name applied to the waters surrounding the city of New York, comprising parts of the Hudson, East, and Harlem rivers, and the upper and lower bays lying respectively inside and outside of the Narrows and between the Long Island, Staten Island, and New Jersey shore.

The city of New York, from which the harbor takes its name, lies at the mouth of the Hudson River at its junction with the East River; and with the adjacent cities of Brooklyn and Jersey City, which are but the natural outgrowths of New York energy and enterprise, includes a population of nearly 3,000,000 inhabitants, which is more than the population of any State in the Union, excepting New York, Pennsylvania, Ohio, Illinois, and Missouri.

At this port two-thirds of the merchandise imported into the United States are received, and two-thirds of the import duties are collected. From this port are sent out one-half of the domestic products of the country which are exported, and here one-half of the foreign tonnage trading with the United States enters. Three-quarters of the passengers traveling between the United States and foreign countries come and go by way of New York, and three-fifths of all immigrants land at this port.

New York Harbor has two entrances, one by the East River and Hell Gate, leading into Long Island Sound, used chiefly by vessels trading between New York, the Eastern States, and the British American Provinces; the other, which is the main entrance, leading out through the Narrows, by Sandy Hook, directly into the Atlantic Ocean.

The Hell Gate entrance has been in course of improvement since 1869, and with its successful completion—which is now assured within a few years—and with the steady growth of the city towards the north, it must come more than ever into use by foreign-bound vessels.

The main or Sandy Hook entrance into New York Harbor is one of the best in the world; the channel prior to 1884 was less than 24 feet deep at mean low water, and nearly 29 feet at mean high water, with abundant breadth, and was ample for all the commercial requirements of the port until the great increase in the length, tonnage, and draught of the trans-Atlantic passenger steamers made further deepening necessary, in order to prevent the delays to which they were subjected by having to wait for high water in order to pass either in or out.

Before the improvement of the Main Ship Channel into New York Harbor was undertaken by the United States, it was obstructed by four shoals, as follows:

1. The outer bar, about 4,000 feet wide, the channel across which is known as Gedney's Channel, where there were depths of 23.7 feet in mid-channel and 22.3 feet in the southern half.

2. The shoal at the mouth of the Swash Channel, about 4,000 feet wide, where the depth was 24.3 feet.

The channel across this shoal has been named the Bayside Channel.

3. The shoal northwest of Sandy Hook, about 2,000 feet wide, on which the least depth was 26.2 feet.

4. The shoal in the Main Ship Channel in the Lower Bay, west of Flynn's Knoll, nearly 3 miles long, on the crest of which the depth was only 23.9 feet in mid-channel, with depth of 22.6 feet within a few hundred feet of the mid-channel range.

A large proportion of the vast commerce of the port, which is carried on in vessels of great draught, could only cross these shoals at or near high water.

The reasonable demand which had been made in 1884, by commercial bodies residing in New York City, that increased facilities should be afforded for entering the port of New York by the Sandy Hook route, was recognized in the river and harbor act of July 5, 1884, which provided for "deepening Gedney's Channel through Sandy Hook Bar, New York, $200,000."

A few words upon the subject of the Lower Harbor and of the various channels across the bar at the entrance are here necessary for a proper understanding of the causes which led to the adoption of the Main Ship Channel for improvement.

Gedney's Channel is the main channel across the Ocean Bar, lying at the entrance to New York Harbor, about 3 miles outside of Sandy Hook and east by north from it. Sandy Hook lies about 9 miles outside of and nearly south from the Narrows, which is the name given to the strait separating the nearest points of Long Island and Staten Island, and the Narrows are about 7 miles south from the Battery at the lower end of the city of New York. The Narrows are about 1 mile wide. That part of New York Harbor lying outside of the Narrows is commonly known as the Lower Bay.

From the Narrows northward to New York City there is no water less than 6 fathoms (36 feet) deep in the main channel.

Lower Bay is a large tidal basin, with an area of about 100 square miles, estimating inside or northward and westward of a line drawn from Sandy Hook to Coney Island.

The western end of the bay formed by Sandy Hook, the adjacent Jersey shore, and Staten Island, is known as Raritan Bay, and the south-

ern part of it inside the peninsula of Sandy Hook is known as Sandy Hook Bay, or more commonly as the Horseshoe.

From the northeast around by the east to south southeast the Lower Bay is open to the full sweep of the Atlantic Ocean.

From the Narrows to the northern point of Sandy Hook is about 9 miles, but the shortest distance across the bay, from the point of Sandy Hook to Coney Island, is 7 miles. The water cross-section on this line at mean low water is about 790,000 square feet, through which the mean velocity is, approximately, 1.6 feet per second, but the maximum velocities are approximately twice as great (Board of Engineers' Report for 1884).

At the Narrows the channel is about 1 mile wide and 70 feet deep, with depths in it of over 100 feet.

Below the Narrows there is one main channel, commonly known as the Main Ship Channel, running southward to a point about 1 mile west of the upper end of Sandy Hook; thence turning at right angles northward and eastward for 4 miles to the head of Gedney's Channel; and thence through Gedney's Channel east to the deep waters of the ocean.

But along and inside the above-mentioned cross-section of 7 miles, between Sandy Hook and Coney Island, there is a bar with five distinct channels running through it seaward and eastward of varying depths.

They lie in the following order, beginning at the northward:

(1) *The Coney Island Channel.*—In which the navigable depth at mean low water is 10 feet.

(2) *The Fourteen-Foot Channel.*—In which the navigable depth at mean low water is 15 feet.

(3) *The East Channel.*—In which the navigable depth of water is 19 feet.

(4) *The Swash Channel.*—Through which 23 feet can be carried at mean low water in a narrow channel, but in which are two lumps over which there is a depth of only 21.9 feet.

(5) *The Main Ship Channel.*—In which, prior to 1885, 24 feet only could be carried through channels with lumps in them with depths of 23.3 feet over them at mean low water. The northern reach, which passes along the west side of Flynn's Knoll, is maintained by tidal flow through the Narrows; and the southern reach, along Sandy Hook, is maintained by tidal flow through Raritan Bay.

These five channels are separated by shoals with from 4 to 18 feet of water upon them at mean low water.

The first three of these channels head directly out into the open sea, but the two latter converge into an area of about 2 miles square, lying north and east of Sandy Hook, which has a depth in it of 30 feet of water and over, and from this deep area, seaward and eastward of it, two channels lead out into the open sea over the outer bar—the northernmost known as Gedney's, the southernmost as the South Channel, both of which had, prior to 1885, only 24 feet of water in them at low water.

Gedney's Channel is the wider and straighter of the two, and is therefore used by all the large vessels.

The Swash Channel is really a cut-off from the main ship-channel, leaving it about 6 miles below the Narrows, and joining it again at the western end of Gedney's Channel.

Apart from being shoaler the Swash is much narrower than the main ship-channel.

The distance from the Battery, at New York, to 30-foot soundings

outside the bar in Gedney's Channel is 22 miles, and by the Swash it is 18 miles, or from the Narrows 15 and 11 miles, respectively.

As the appropriation of 1884 was made in advance of an approved project, the local officer was authorized and directed to make a survey of the lower harbor from the eastern end of Coney Island to Sandy Hook with a view of determining the most feasible plan of improvement. The survey was completed in November, 1884, and a report recommending the eventual improvement of the main ship-channel, accompanied with estimates of cost and chart, was submitted December 6, 1884 (Annual Report Chief of Engineers, 1885, page 773).

The project provides for an improved channel 1,000 feet wide and 30 feet deep, mean low water, at a cost of $970,000.

The navigation of the main ship-channel inside the bar, especially on the approach to the Narrows from the Southwest Spit, is so intimately connected with that of Gedney's Channel, across the bar, that it was deemed important in submitting an estimate of cost for the improvement of the latter channel, directed to be made by Congress in the act of 1884, to extend the estimate to include the entire main ship-channel from the Narrows to the deep water beyond the bar, and to state that the improvements at the several intermediate shoals should take place simultaneously. The project providing for deepening the channel across the bar to 28 feet by dredging and for the contingent construction of a stone dike on the north side of the harbor, which had been recommended by a Board of Engineers December 24, 1884, received the approval of the Secretary of War December 27, 1884 (Annual Report Chief of Engineers, 1885, Part I, page 774).

The next river and harbor act, August 5, 1886, containing provisions for continuing the improvement at the entrance to New York Harbor, reads as follows:

Improving New York Harbor, New York: To secure a 30-foot channel at mean low water at Sandy Hook entrance of the harbor, upon such a plan as the Secretary of War may approve, $750,000.

By the specific wording of this act, Congress gave an express approval of an improvement which contemplated a navigable channel 1,000 feet wide and 30 feet deep, mean low water, from the Narrows, through the main ship-channel and Gedney's Channel, to deep water outside the bar, and all subsequent acts have confirmed the provisions of the act of 1886.

The estimate of cost for opening the projected channel by dredging, revised in 1886, was fixed at $1,370,000, which was again increased in 1887 to $1,490,000.

The first operations began September 26, 1885, and the plant which had been used for the execution of the improvement has consisted solely of centrifugal pumps, and the excavations have been deposited beyond the bar in the vicinity of the Scotland Light-Vessel.

The quantity which has been removed from the several reaches of the main ship-channel from September 26, 1885, to June 30, 1890, may be classified as follows:

	Cubic yards.
From Gedney's Channel	1,055,090
From Bayside Channel	448,313
From Northwest Shoal	118,758
From west of Flynn's Knoll	1,978,973
Total quantity excavated	3,601,134

The amount expended to June 30, 1889, inclusive of outstanding liabilities, was $808,411.74.

WORK DONE DURING THE FISCAL YEAR.

At the beginning of the year there were in force the following contracts:

1. Contract with the Joseph Edwards Dredging Company, dated May 19, 1887, for the removal of 1,500,000 cubic yards from the main ship-channel, at 28½ cents per cubic yard; expired December 1, 1888; extended by authority of the Chief of Engineers to June 30, 1889, and again extended to December 31, 1889.

2. Agreement with Brainard Brothers, dated May 11, 1888, for the removal of 200,000 cubic yards from the main ship-channel, at 28½ cents per cubic yard; expired December 1, 1888; extended by authority of the Chief of Engineers to June 30, 1889, and again extended to December 31, 1889.

3. Agreement with the Joseph Edwards Dredging Company, dated December 15, 1888, for the removal of 600,000 cubic yards from the Gedney's Channel Division, at 17 cents per cubic yard; expired January 1, 1890.

The Joseph Edwards Dredging Company continued operations with their three machines under their contract for the main ship-channel, and under their agreement for the Gedney's Channel Division, until November 30, 1889, and December 3, 1889, respectively, at which times both operations were completed and the plant was withdrawn from the work.

Brainard Brothers completed their agreement for the main ship-channel, September 30, 1889, and their dredge *Leo* was then withdrawn.

On September 13, 1889, advertisements were issued inviting proposals for the removal of 1,000,000 cubic yards of material from the main ship-channel, west of Flynn's Knoll, and bids were opened October 17, 1889. By direction of the Chief of Engineers a contract was entered into with the lowest bidder, the Brainard Dredging Company, dated November 26, 1889, for the removal of 1,000,000 cubic yards, at 16⅞ cents per cubic yard.

Work under this contract began January 18, 1890, with the dredge *Leo* and scows. The contractor attempted to increase the efficiency of this dredge by adding two 15-inch centrifugal pumps and suctions to the original 22-inch pump, and to pump simultaneously into two scows, one on each side of the dredge. The new pumps never worked satisfactorily, and the result was not a success.

The dredge *Leo*, on April 16, 1890, was libeled for debt, withdrawn from the work, and sold June 17, 1890. The quantity of material removed by her up to the time of her withdrawal was 71,325 cubic yards.

On March 22, 1890, the dredge *Mount Waldo* and scows began work under the Brainard Dredging Company contract, by agreement either with that company direct or with its representatives, but was withdrawn on June 18, 1890, at which time the contract was recommended to be annulled, as the contractor had then no plant upon the work. The quantity of material removed by the *Mount Waldo* on the above contract was 168,757 cubic yards.

Proposals were invited by public advertisement and opened March 13, 1890, for the removal of 500,000 cubic yards of material from the main ship-channel north of Buoy No. 12. But one bid, presented by the Joseph Edwards Dredging Company, at 23½ cents per cubic yard, was received, and being considered reasonable a contract was entered

into with this company March 18, 1890 approved by the Chief of Engineers April 11, 1890, for the removal of 425,000 cubic yards.

Operations under this contract began with the dredge *Advance* April 2; with the dredge *Reliance* April 4; and with the dredge *Mount Waldo* June 18, 1890.

A table showing the quantity of material removed under the various contracts during the fiscal year is appended; also, a table showing the monthly performance of the three dredges of the Joseph Edwards Dredging company under its completed contracts.

Proposals were invited by public advertisement and opened March 31, 1890, for the delivery of 5,000 tons of broken stone at Sandy Hook, N. J., for the construction of a riprap sea-wall for protection of the north shore of Sandy Hook. A contract was made with J. S. Howell, the lowest bidder, dated May 12, 1890, for the delivery of 5,000 tons of broken stone at 90 cents per ton. Up to the close of the fiscal year no stone has been delivered under this contract.

Surveys of all the channels undergoing improvement were made in July, 1889, and again during January and February, 1890. These surveys show that the improvement is in a very satisfactory condition. Gedney's Channel and Bayside Channel (east and west) are practically completed, having a depth of 30 feet, mean low water, for the full projected width of 1,000 feet. The main ship-channel west of Flynn's Knoll has a depth of 30 feet, mean low water, for a width of from 500 to 800 feet, and a depth of 28 feet for a width of 800 feet throughout.

The severe storm of September 9, 1889, which caused a suspension of work for one week, does not appear to have had any effect on the improved channels. There is no evidence of shoaling, and the soundings of the various surveys agree so well with one another that it seems highly probable that the improved depths will be well maintained by the currents, and, if not self-sustaining, that the deterioration will be so gradual as to require a long interval of time before it will become apparent. Charts of the surveys were printed for public distribution, and are in demand by pilots and mariners, to whom they prove to be of great value.

It is estimated that on the completion of existing contracts, 630,000 cubic yards will remain to be removed to complete the project for 30 feet depth at mean low water in a channel width of 1,000 feet from the Narrows to the sea. If the appropriation of $160,000 contained in the pending river and harbor act is made, it is believed that sufficient funds will thereafter be available for completing the project unless large unforeseen shoalings take place.

According to written statements made to this office by largest steamship companies, steamers, outward-bound, leave their dock two hours before high water at Sandy Hook so as to cross the bar at the top of high water; when inward-bound, they cross the bar regardless of the stage of the tide, excepting when it is too late to pass quarantine (after sunset). When the project is completed and a navigable channel 30 feet deep at mean low water is obtained it will be practicable for the steam-ship companies to establish a regular hour of sailing without regard to the tides. The draught outward-bound is usually greater than inward-bound vessels by 1½ to 2 feet, owing to larger tonnage of coal and cargo. A table giving the names, dimensions, and draughts of transatlantic steamers accompanies this report.

This improvement, as well as others, has been under the local charge of Mr. G. W. Kuehnle, assistant engineer, during the year, to whom I am indebted for the most satisfactory and intelligent manner in which he has discharged his various duties.

Material removed from Gedney's and Main Ship channels, New York Harbor, from August 1887, *to December*, 1889, *by the Joseph Edwards Dredging Company, under their contracts dated April* 21, 1887, *for* 700,000 *cubic yards, and May* 19, 1887, *for* 1,500,000 *cubic yards, and their agreement dated December* 15, 1888, *for* 600,000 *cubic yards.*

	Dredge *Advance.*				Dredge *Mount Waldo.*			
	Gedney's.	Main Ship.	Bayside.	Shoal.	Gedney's.	Main Ship.	Bayside.	Shoal.
1887.								
August	17,395							
September	30,864							
October	34,168				8,869			
November	33,981				24,795			
December		8,773			2,656	8,418		
1888.								
January		1,239				2,736		
February		9,563				9,071		
March		14,512				5,469		
April		19,956				19,462.5		
May		6,308	30,146			30,629.2		
June			31,454			46,656.8		
July			52,837			53,515.1		
August			50,213			57,884.0		
September			33,709			43,585.5		
October		10,870	18,574			47,314.4		
November	15,413	9,294				41,007.9		
December	10,05[illegible]	6,124	7,689			34,214.6		
1889.								
January		1,507	23,991	741		7,774.0	10,863	6,700
February			30,456	1,209			1,549	20,346
March		3,393	4,207	15,604			13,304	5,353
April		8,043		10,231		17,409		10,333
May		15,293		3,500		65,593		
June						70,123		
July	40,758	227				71,279		
August	69,616					58,654		140
September	57,368					46,220		
October	31,189	17,253				58,405		
November	62,381	1,297				37,210		
December	4,002							
	407,192	133,652	283,276	31,285	36,320	832,631	25,716	42,872

	Dredge *Reliance.*				
	Gedney's.	Main Ship.	Bayside.	Shoal.	Total.
1887.					
August					17,395
September					30,864
October					43,037
November	3,496.0				62,272
December		7,084.1			26,931.1
1888.					
January		4,567.9			8,542.9
February		9,048.9			27,682.9
March		13,681.0			33,762.6
April		29,517.4			68,935.9
May		9,052.3	36,957		113,092.5
June	41,138.8		22,932		142,181.6
July	39,632.7				175,984.8
August	68,332.4				176,429.4
September	52,831.2				130,125.7
October	19,318.9	16,361.6			112,438.9
November	18,208.9	6,590.1	6,046.3		96,560.2
December	8,089.4	4,991.6	20,427.5	4,768	96,361.1
1889.					
January		19,759.7			71,335.7
February		20,816.0			74,376.0
March		12,234	523.0		54,618.0
April		1,467			47,483
May		39,077			123,463
June		40,385			110,508
July		44,209			156,473
August		40,422			168,832
September		13,010	27,099.0		143,697
October		4,456	13,733.0	31,350	156,386
November	20,579	2,489	10,030.0	8,387	146,375
December					
	301,627.3	339,219.8	137,747.3	44,505	2,616,043.7

Statement of material removed under the various contracts and agreements during the fiscal year ending June 30, 1890.

	Cubic yards.	Cubic yards.
Under contract with the Joseph Edwards Dredging Company, dated May 19, 1887, for the removal of 1,500,000 cubic yards from the Main Ship Channel (completed November 30, 1887):		
Mount Waldo	271,768	
Reliance	104,586	
Advance	18,777	
		395,131
Under agreement with Brainard Brothers, dated May 11, 1888, for the removal of 200,000 cubic yards from the Main Ship Channel (completed September 30, 1889):		
Leo	72,644	
		72,644
Under agreement with the Joseph Edwards Dredging Company, dated December 8, 1888, for the removal of 600,000 cubic yards from the Gedney's Channel Division (completed December 3, 1889):		
Reliance	111,178	
Advance	265,314	
Mount Waldo	140	
		376,632
Under contract with the Brainard Dredging Company, dated November 26, 1889, for the removal of 1,000,000 cubic yards from the Main Ship Channel:		
Leo	71,325	
Mount Waldo	168,757	
		240,082
Under contract with the Joseph Edwards Dredging Company, dated March 18, 1890, for the removal of 425,000 cubic yards from the Main Ship Channel:		
Reliance	106,727	
Advance	88,475	
Mount Waldo	38,487	
		233,689
Total		1,318,178

This work is in the collection district of New York. Nearest light-houses, Sandy Hook and Highland Lights. The nearest forts are the fort at Sandy Hook and those at the Narrows.

AMOUNTS APPROPRIATED.

For Gedney's Channel:	
By act July 5, 1884	$200,000
For New York Harbor:	
Act August 5, 1886	750,000
Act August 11, 1888	380,000
Total	1,330,000

Amount expended to June 30, 1890, inclusive of outstanding liabilities, $1,135,696.80

Money statement.

July 1, 1889, amount available		$315,581.40
July 1, 1890, money value of work done during fiscal year under contracts made prior to June 30, 1889		206,006.86
		521,588.26
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$288,071.41	
July 1, 1890, outstanding liabilities	39,213.65	
July 1, 1890, amount covered by uncompleted contracts made during the fiscal year ending June 30, 1890	177,694.24	
		504,979.30
July 1, 1890, balance available		16,608.96
Amount appropriated by act of September 19, 1890		160,000.00
Amount available for fiscal year ending June 30, 1891		176,608.96

Abstract of proposals for improving New York Harbor, New York, received in response to the advertisement, dated September 13, 1889, and opened October 17, 1889, by Lieut. Col. G. L. Gillespie, Corps of Engineers, U. S. Army.

No.	Name of bidder.	Price bid for dredging per cubic yard, measured in dredges or scows.	Total amount for 1,000,000 cubic yards.
		Cents.	
1	James A. Simmons	24½	$245,000
2	The Joseph Edwards Dredging Company	22 3/10	226,000
3	The Brainard Dredging Company	*16¾	168,750

* Lowest bid.

Abstract of proposal for improving New York Harbor, received in response to the advertisement dated February 7, 1890, and opened March 13, 1890, by Lieut. Col. G. L. Gillespie, Corps of Engineers, U. S. Army.

No.	Name of bidder.	Price bid per cubic yard, measured in scows.	Total amount for dredging 500,000 cubic yards.
		Cents.	
1	The Joseph Edwards Dredging Company	*23½	$117,500

* Only bid received.

Abstract of proposals for the delivery of broken stone at Sandy Hook, New Jersey, received in response to the advertisement dated February 27, 1890, and opened March 31, 1890, by Lieut. Col. G. L. Gillespie, Corps of Engineers, U. S. Army.

No.	Name of bidder.	Harlem River stone, 5,000 tons.				Stone furnished by bidder, 5,000 tons.			
		On scows alongside dock.		Stone upon dock.		On scows alongside dock.		Stone upon dock.	
		Per ton.	Total.	Per ton.	Total.	Per ton.	Total.	Per ton.	Total.
1	North River Blue Stone Company					$1.24	$6,200	$1.48	$7,450
2	John S. Howell					*.90	4,500	1.28	6,400
3	Brown & Fleming	$1.25	$6,250	$1.50	$7,500	1.15	5,750	1.35	6,750
4	John E. Walsh	1.42½	7,125	1.63½	8,175	1.28½	6,425	1.43	7,150

* Lowest bid.

COMMERCIAL STATISTICS.

The following statement concerning the commerce of New York Harbor is taken from the report of the Chamber of Commerce of the State of New York for the year 1889–'90:

Articles.	Imported.		Exported.		Total value.
	Quantity.	Value.	Quantity.	Value.	
Sugar.....pounds..	1,463,051,343	$42,943,453	.....	.....	$42,943,453
Molasses.....gallons..	8,498,875	1,424,251	.....	.....	1,424,251
Coffee.....pounds..	455,979,016	58,860,319	.....	.....	58,860,319
Tea.....do....	58,476,531	9,643,514	.....	.....	9,643,514
Manufactures of wool, silk, cotton, and flax.....	.....	111,234,883	.....	7,728,397	118,962,280
Cotton.....pounds..	.....	.....	536,614,048	54,701,315	54,701,315
Leather and hides.....	.....	25,760,160	.....	4,906,214	30,666,374
Tin.....pounds..	327,279,151	14,825,588	.....	.....	14,825,588
Raw silk and wool.....do....	55,505,689	13,949,577	.....	.....	13,949,577
Hemp, jute, sisal-grass, etc..tons..	149,263	13,431,215	.....	.....	13,431,215
India-rubber and gutta percha, crude.....pounds..	28,952,361	11,094,063	.....	.....	11,094,063
Tobacco, and manufactures.....	.....	10,147,883	.....	15,291,084	25,438,967
Furs, and manufactures.....	.....	4,748,971	.....	4,724,017	9,472,988
Earthen, stone, and china ware....	.....	3,230,780	.....	.....	3,230,780
Wines.....	.....	6,156,821	.....	.....	6,156,821
Coin and bullion.....	.....	7,274,618	.....	69,724,274	76,998,892
Precious stones.....	.....	9,498,209	.....	9,498,209	
Miscellaneous.....	.....	135,203,820	.....	75,006,102	210,209,922
Breadstuffs:					
Wheat.....bushels..	.....	.....	9,086,407	8,449,510	8,449,510
Wheat flour.....barrels..	.....	.....	3,335,195	15,498,193	15,498,193
Corn.....bushels..	.....	.....	26,658,970	13,066,961	13,066,961
All other breadstuffs.....	.....	.....	.....	1,765,287	1,765,287
Provisions.....pounds..	.....	.....	753,007,846	64,504,425	64,504,425
Mineral oils.....gallons..	.....	.....	418,773,072	36,049,956	36,049,956
Cattle.....	.....	.....	75,004	6,204,624	6,204,624
Oil cake and meal.....pounds..	.....	.....	231,034,183	3,032,066	3,032,066
Foreign merchandise.....	.....	.....	.....	16,727,560	16,727,560
Total.....	.....	479,428,125	.....	397,379,985	876,808,110

This table shows an increase of $24,642,419 over the total value of imports and exports for the preceding year, which amounted to $852,165,691.

List of transatlantic steam-ships plying between New York City and foreign ports, giving tonnage, dimensions, and draught (incoming and outgoing) for the year 1885, *and from April,* 1889, *to April,* 1890.

[The authority for date of construction and dimensions of steam-ships is Lloyd's Register, 1889 to 1890. All draughts taken from records at New York pilot commissioner's office.]

Name of vessel.	When built.	Tonnage.		Length.	Breadth.	Depth of hold.	Average draught.				Deepest draught.		Date of deepest draught.
							1885.		1889.				
		Net.	Gross.				Incoming.	Outgoing.	Incoming.	Outgoing.	1885.	1889.	
Anchor Line.				*Ft. In.*	*Ft. In.*	*Ft. In.*	*Ft. In.*	*Ft. In.*	*Ft. In.*	*Ft. In.*	*Ft. In.*	*Ft. In.*	
Alexandria	1870	1,247	2,017	300 5	38 2	22 6 29 4	20 3	22 7	22 6	.....	23 0	.....	
Alsatia	1876	1,793	2,773	356 7	36 2	29 4	21 1	23 11	21 4	23 7	23 3	24 2	Apr. 27, 1889
Anglia	1888	2,120	3,287	340 0	43 0	27 8	.....	.....	.....	.....	.....	25 6	Feb. 12, 1890
Anchoria	1874	2,713	4,157	408 0	40 1	33 8	22 3	24 9	23 0	25 0	25 5	25 3	
Asia	1884	2,323	3,561	378 2	40 2	28 6	22 6	21 0	.....	.....	22 6	.....	
Australia	1870	1,455	2,252	324 6	35 2	22 5 29 3	.....	.....	20 3	22 0	.....	22 4	Apr. 22, 1889
Austral*	1881	3,271	5,588	297 9	37 1	22 9	.....	.....	.....	21 8	.....	23 0	Feb. 21, 1890
Belgravia	1881	3,275	4,977	400 0	44 8	33 0	.....	.....	.....	26 10	.....	26 10	July 19, 1889
Bolivia	1873	2,626	4,050	400 0	40 0	25 1 33 0	.....	.....	22 0	24 7	.....	24 10	Mar. 5, 1890
Britannia	1879	1,991	3,069	350 6	38 5	28 7	.....	.....	18 6	20 0	.....	20 0	Oct. 31, 1889
Bitterne†	.....	.....	.....	.....	.....	.....	19 11	27 0	.....	.....	27 0	.....	
City of Rome	1881	3,453	3,144	560 2	52 3	37 0	24 8	26 6	24 11	27 2	27 0	27 3	Oct. 16, 1889
Columbia	1866	1,322	2,030	283 3	33 6	22 2	20 9	22 6	22 8	.....	22 6	.....	
California	1872	2,214	3,410	361 5	40 5	24 2	22 0	24 7	22 9	24 8	24 6	25 2	Aug. 16, 1889
Elysia	1873	1,745	2,714	351 0	35 0	29 7	19 9	22 6	.....	23 0	22 6	23 0	Jan. 19, 1889
Furnessia	1880	3,613	5,495	445 1	44 8	34 5	24 8	26 8	24 7	27 2	27 0	27 3	Jan. 4, 1890
India	1868	1,592	2,477	311 6	36 7*	23 6	19 8	21 11	.....	22 10	223 3	22 10	
Italia	1872	1,442	2,236	306 0	34 4	21 9	20 10	23 8	21 8	21 6	22 8	21 6	
Olympia	1871	1,416	2,193	307 1	34 6	29 0	21 1	21 8	22 0	22 9	21 9	23 3	Apr. 28, 1889
Scotia	.....	1,890	2,765	318 0	40 6	29 0	18 3	20 10	.....	.....	21 6	.....	
Trinacria	1871	1,466	2,256	306 0	34 4	29 3	19 2	22 6	.....	.....	22 9	.....	
Utopia	1874	1,754	2,731	350 2	35 2	29 5	.....	.....	18 6	23 2	.....	23 9	May 25, 1889
Victoria	1872	2,208	3,358	360 0	40 1	24 0	.....	.....	21 10	21 9	.....	22 9	Dec. 28, 1889
Circassia	1878	2,770	4,272	399 7	42 0	25 1	22 10	24 6	23 5	24 10	25 6	25 3	
Devonia	1877	2,772	4,270	400 3	42 0	25 1 33 2	23 1	24 10	23 0	24 8	25 3	25 0	
Ethiopia	1873	2,604	4,005	402 0	40 2	24 8	21 6	23 9	22 3	23 11	24 9	24 0	
Hesperia	1882	1,982	3,037	340 5	37 7	29 5	23 9	25 0	.....	.....	25 0	.....	

Hispania	1880	2,213	3,380	364 3	38 0	28 6	.....	.....	22 4	24 2	.....	24 4	Dec. 15, 1889
Assyria	1871	1,249	2,023	300 5	33 2	22 6 29 4	20 0	*22 9	21 8	22 4	23 0	24 6	Apr. 19, 1890
Arrow Line (Compañia de Navigacion "La Flecha").													
Hugo	1872	1,713	2,652	370 0	36 8	27 9	23 4	.....	23 1	23 6	23 4	23 6	Aug. 16, 1889
Compagnie Bourdelaise de Navigation à Vapeur.													
Chateau Lafitte	1881	2,253	3,462	366 2	41 1	22 0 30 0	19 11	23 6	20 1	23 7	24 6	24 3	
Compagnie Française de Navigation à Vapeur.													
Alesia	1882	2,131	2,851	328 0	40 4	27 1	18 3	22 4	18 0	23 3	23 0	24 0	July 10, 1889
Britannia	1881	1,846	2,490	328 0	40 4	23 4	17 10	20 10	18 8	21 5	21 0	23 0	May 23, 1889
Burgundia	1882	2,169	2,856	328 0	40 3	27 1	.....	.....	15 5	23 6	.....	24 0	May 23, 1889
Neustria	1883	1,949	2,946	328 4	40 0	27 2	19 9	21 7	.....	23 5	22 0	23 6	June 5, 1889 Aug. 6, 1889
Compagnie Générale Transatlantique.													
La Bourgogne	1885	3,786	6,800	494 4	52 2	34 4	.....	.....	25 3	26 0	.....	26 6	Dec. 21, 1889
La Bretagne	1886	3,396	6,920	495 4	51 8	33 5	.....	.....	24 6	25 5	.....	26 0	Mar. 15, 1890
La Champagne	1885	3,413	6,800	493 4	51 8	33 8	.....	.....	25 1	25 9	.....	27 0	Mar. 2, 1890
La Gascogne	1885	3,766	6,800	425 4	52 2	34 4	.....	.....	26 0	27 0	.....	27 0	May, 1889, to Feb., 1890.
La Normandie	1882	3,254	6,217	459 3	49 2	37 4	23 5	24 8	23 9	24 9	26 0	25 6	
La Touraine‡	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Cunard Line.													
Aurania	1883	4,030	7,269	470 0	57 2	37 2	23 6	26 2	24 0	26 6	26 8	27 0	Sept. 21, 1889 Aug. 24, 1889
Bothnia	1874	2,923	4,535	422 3	42 2	34 5	21 3	23 0	22 2	23 6	23 4	24 4	Sept. 25, 1889
Etruria	1884	3,391	7,790	501 6	57 2	38 2	25 2	26 4	25 2	27 4	26 9	27 11	Sept. 15, 1889 Nov. 9, 1889
Gallia	1879	2,898	4,809	430 1	44 6	34 4	22 8	23 6	22 8	24 1	24 2	24 10	Mar. 22, 1890
Pavonia§	1882	3,490	5,588	430 5	46 4	34 9	23 6	25 0	.....	.....	25 0	.....	
Scythia§	1875	2,907	4,557	420 8	42 2	34 6	22 0	22 8	.....	.....	22 8	.....	
Servia	1881	3,971	7,392	515 0	52 1	37 0	23 7	25 5	24 0	26 3	25 8	27 0	Dec. 28, 1889
Umbria	1884	3,401	7,798	501 6	57 2	38 2	.....	.....	24 10	27 4	.....	28 0	Jan. 18, 1890
Guion Line.													
Alaska	1883	4,000	7,500	525 0	50 6	40 7	25 4	26 0	26 5	26 8	26 4	27 0	Nov. 5, 1889
Arizona	1879	2,657	5,564	450 2	45 4	35 7	23 4	25 6	23 5	25 3	26 0	26 0	Aug. 6, 1889
Nevada	1869	2,355	3,617	345 6	43 4	35 1	22 8	24 4	23 3	24 1	25 3	24 6	
Wisconsin	1870	2,386	3,720	366 0	43 2	26 6	21 6	24 9	21 11	23 9	25 0	24 4	
Wyoming	1870	2,415	3,716	366 2	43 2	26 8	21 11	22 1	22 8	23 9	22 6	24 0	Nov. 12, 1889 Feb. 26, 1890

*Australian trade. †Sold to French line. ‡Building. §Boston and Europe.

List of transatlantic steam-ships plying between New York City and foreign ports, etc.—Continued.

Name of vessel.	When built.	Tonnage.		Length.	Breadth.	Depth of hold.	Average draught.				Deepest draught.		Date of deepest draught.
							1885.		1889.				
		Net.	Gross.				Incoming.	Outgoing.	Incoming.	Outgoing.	1885.	1889.	
Hamburg American Packet Company.				Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	
Augusta Victoria	1889	3,736	.....	462 0	56 ½	.....	.....	.....	22 9	26 1	.....	26 8	May 23, 1889
California	1883	2,163	2,690	300 5	38 7	22 5	21 6	21 9	21 6	21 4	22 8	24 4	Sept. 15, 1889
Dania	.....	2,926	.....	350 0	45 0	.....	.....	.....	21 0	25 0	.....	25 0	Feb. 22, 1890
Gellert	1874	2,350	3,533	374 0	40 0	32 2	20 6	22 9	21 6	23 7	23 0	24 0	Oct. 17, 1889
Hammonia	1882	2,563	3,969	373 7	45 3	32 0	.....	25 4	21 7	23 8	25 4	24 2	Sept. 17, 1889
Italia	.....	2,263	3,498	344 1	43 3	29 2	.....	.....	.....	23 3	.....	24 6	Mar. 30, 1890
Lessing	1874	2,260	3,460	375 0	40 0	32 0	19 4	21 11	.....	.....	23 0	.....	
Moravia	1883	2,417	3,730	360 9	40 7	22 3	20 1	24 0	.....	24 7	24 6	24 7	May 23, 1889
Normannia	1890	3,750	8,250	502 0	57 6	34 0	.....	.....	.....	.....	.....	.....	
Rhaetia	1883	2,627	3,553	351 1	43 0	29 1	18 7	22 5	20 5	23 3	23 0	23 9	Aug. 24, 1889
Rugia	1882	2,481	3,467	357 7	43 0	28 7	20 0	21 4	.....	22 0	21 6	22 0	June 6, 1889
Russia	.....	2,926	.....	350 0	45 0	.....	.....	.....	21 10	25 11	.....	26 5	Mar. 28, 1890
Scandia	.....	2,926	.....	350 0	45 0	.....	.....	.....	.....	24 8	.....	24 8	Mar. 22, 1890
Suevia	1874	2,440	3,609	364 2	41 3	33 8	18 9	21 10	20 10	21 7	25 6	22 3	
Westphalia*	.....	.....	.....	335 0	42 0	.....	.....	21 8	.....	.....	22 0	.....	
Wieland	1874	2,358	3,504	384 0	40 0	32 6	20 3	22 1	.....	22 1	22 6	22 10	July 23, 1889
Bohemia	1881	2,216	3,410	350 5	40 7	23 0	18 11	23 8	19 6	23 4	24 0	23 7	
Columbia	1889	3,736	.....	462 0	56 ½	.....	.....	.....	22 3	26 4	.....	26 8	Apr. 24, 1890
Polaria	1882	2,075	2,724	300 0	38 2	24 9	19 3	21 6	.....	.....	22 0	.....	
Polynesia	1881	1,675	2,196	298 7	36 0	23 2	18 9	20 4	.....	.....	21 0	.....	
Slavonia	1883	1,676	2,274	300 0	37 0	25 7	.....	.....	18 7	21 8	.....	22 0	June 18, 1889 Apr. 20, 1889
Hamburg Line.													
Amalfi	1881	1,792	2,345	300 5	36 1	25 2	.....	.....	18 9	22 3	.....	22 6	Oct. 12, 1889 Feb. 20, 1890
Marsala	1882	1,574	2,397	320 2	36 2	24 6	.....	.....	.....	21 9	.....	21 9	May 23, 1889
Sorrento	1881	1,527	2,371	320 0	36 2	24 6	.....	.....	.....	22 6	.....	23 4	Feb. 28, 1890
Taormina	1884	1,565	2,422	320 0	38 7	25 6	.....	.....	19 0	21 0	.....	21 0	June 22, 1889
Inman Line.													
City of Berlin	1874	3,302	5,526	488 6	44 2	34 9	22 5	24 5	22 5	*25 4	25 7	25 8	Dec. 19, 1889
City of Montreal†	.....	.....	.....	.....	.....	.....	22 4	*25 0	.....	.....	25 10	.....	
City of Chester	1873	2,944	4,770	444 6	44 2	34 6	23 0	25 10	22 8	26 0	26 7	26 0	

City of Chicago	1883	3,383	5,202	430 6	45 0	33 6	22 0	24 2	22 1	25 10	24 9	25 10	Jan. 30, 1890
City of New York	1888	5,930	10,499	527 6	63 2	22 0 39 2	.....	.....	23 6	26 2	.....	26 6	Sept. 18, 1889
City of Richmond	1873	2,957	4,780	440 8	43 5	34 1	23 5	26 2	22 0	25 10	26 6	26 1	
City of Paris	1889	5,581	10,499	527 6	63 2	22 0	.....	.....	23 11	26 5	.....	27 0	May 15, 1889
Ludgate Hill Line.													
Ludgate Hill	1881	2,635	4,063	420 3	47 0	26 5	17 2	23 5	18 6	23 4	25 0	23 6	
National Line.													
Canada	1863	2,709	4,276	391 6	41 2	35 2	21 7	24 9	22 11	25 10	25 9	27 4	May 25, 1889
Denmark	1865	2,326	3,724	342 9	42 2	36 0	22 1	25 10	21 8	26 5	26 6	27 1	Sept. 28, 1889
Egypt	1871	2,959	4,670	440 3	44 6	36 5	24 2	25 7	23 11	27 3	26 0	28 0	Nov. 29, 1889
England	1865	3,022	4,898	437 9	42 5	35 0	21 11	24 5	22 0	25 5	24 7	26 3	Aug. 7, 1889
Erin‡	1864	2,848	4,577	418 8	41 2	35 3	21 7	26 1	23 0	26 9	26 6	27 5	Apr. 3, 1889
France	1867	2,713	4,281	385 6	42 4	28 7	21 4	26 3	23 0	26 5	26 7	27 0	Dec. 6, 1889
Greece	1863	2,712	4,310	390 7	41 3	35 3	20 7	25 11	22 2	25 11	26 6	27 2	Nov. 6, 1889
Helvetia	1864	2,855	4,588	419 2	41 2	35 6	21 4	25 4	23 1	25 7	25 10	26 5	June 23, 1889
Holland	1862	2,419	3,847	395 1	40 8	33 2	20 0	23 0	21 3	23 8	23 1	24 10	Dec. 15, 1889
Italy	1870	2,624	4,169	389 0	42 3	28 7	.....	.....	23 4	27 0	.....	28 4	Oct. 10, 1889
Spain	1871	2,794	4,512	425 4	43 2	36 2	23 3	26 1	23 7	27 5	26 8	27 9	Aug. 21, 1889
The Queen	1865	2,732	4,457	381 1	42 4	37 3	.....	.....	22 10	26 6	.....	27 2	Aug. 15, 1889
Netherlands American Steam Navigation Company.													
Amsterdam	1879	2,650	3,664	410 3	39 0	28 9	.....	.....	19 10	23 10	.....	24 7	Nov. 14, 1889
Edam§	1883	2,267	3,130	328 1	41 3	29 5	18 9	22 4	20 8	23 0	23 6	23 0	
Leerdam*	1881	2,118	2,796	322 1	40 0	30 0	18 3	21 10	.....	.....	22 6	.....	
Maasdam	1871	2,187	3,707	420 0	40 9	31 0	.....	.....	20 0	24 6	.....	24 6	Apr. 3, 1890
Obdam	1880	2,277	3,558	410 3	39 0	28 9	.....	.....	20 4	24 2	.....	25 0	Sept. 26, 1889
P. Caland§	1874	1,827	2,584	350 1	38 1	19 7	18 1	20 9	.....	.....	21 6	.....	
Rotterdam	1878	2,361	3,329	389 6	37 9	28 3	.....	.....	.....	23 2	.....	23 9	Aug. 1, 1889
Schiedam§	1874	2,085	2,744	301 0	39 3	23 2	19 2	21 11	.....	.....	22 6	.....	
Veendam	1871	2,209	3,707	420 0	40 9	31 0	.....	.....	21 1	23 10	.....	24 6	Aug. 29, 1889
Zaandam§	1882	2,282	3,063	328 1	39 4	29 5	21 4	23 6	.....	.....	23 9	.....	
Norddeutscher Lloyd.													
Aller	1885	2,779	5,381	438 0	48 1	34 6	.....	.....	23 4	25 4	.....	26 2	Aug. 7, 1889
Donau	1868	1,771	2,896	347 8	40 0	33 5	18 10	21 8	.....	.....	22 6	.....	
Eider	1884	2,952	4,719	429 8	46 9	34 5	23 5	24 10	22 7	24 6	25 2	25 0	
Ems	1884	2,893	5,192	429 8	47 0	34 8	22 8	24 8	22 8	24 7	25 5	25 2	
Elbe	1881	2,810	4,510	418 2	44 9	35 4	22 2	24 11	22 4	25 1	25 4	25 7	Oct. 6, 1889
Fulda	1882	2,864	5,124	429 8	45 9	27 0	23 2	25 3	22 10	24 10	25 6	26 0	Jan. 8, 1890
General Werder	1874	1,820	3,020	352 7	39 4	31 1	17 7	19 4	.....	.....	19 6	.....	
Habsburg	.....	.....	3,094	.....	.....	.....	19 10	22 3	.....	.....	22 3	.....	
Hohenzollern	1873	2,107	3,098	353 0	39 4	32 5	19 0	21 1	.....	.....	21 8	.....	
Kaiser Wilhelm II	1889	.....	6,990	449 6	51 0	35 6	.....	.....	24 0	26 6	.....	26 6	Sept. 28, 1889
Lahn	1887	2,879	5,661	448 4	49 0	34 9	.....	.....	23 9	25 11	.....	26 2	May 8, 1889
Main	1868	1,913	3,087	347 8	40 0	33 8	19 0	21 3	.....	.....	21 6	.....	
Neckar	1874	1,870	3,120	351 1	39 7	33 5	20 3	21 6	.....	.....	22 0	.....	

* Sold. † Burnt 1887. ‡ Lost January, 1890. § South American trade.

List of transatlantic steam-ships plying between New York City and foreign ports, etc.—Continued.

Name of vessel.	When built.	Tonnage.		Length.	Breadth.	Depth of hold.	Average draught.				Deepest draught.		Date of deepest draught.
							1885.		1889.				
		Net.	Gross.				Incoming.	Outgoing.	Incoming.	Outgoing.	1885.	1889.	
Norddeutscher Lloyd—Continued.				Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	
Oder*							19 9	21 9			22 6		
Rhein	1868	1,763	2,901	349 1	40 0	33 8	18 8	21 0			22 2		
Saale	1886	2,779	5,381	439 6	48 5	34 8			23 8	25 2		25 6	Oct. 16, 1889 Dec. 11, 1889
Salier	1875	1,894	3,083	354 4	39 7	32 6	20 6	21 11			22 0		
Trave	1886	2,779	5,381	438 6	48 1	34 6			23 1	24 10		25 8	Dec. 18, 1889
Weser	1867	1,995	2,823	351 1	40 0	33 8	19 6	21 6	20 3	18 1	21 6	20 3	
Werra	1882	2,856	5,109	433 1	45 9	35 8	22 8	25 2	22 11	25 0	25 7	25 9	Jan. 20, 1890
Red Star Line.													
Friesland	1889	4,560	7,116	437 0	51 2	35 0			23 0	24 3		24 6	Mar. 19, 1890
Nederland	1873	1,819	2,839	329 2	38 6	30 5							
Noordland	1883	3,346	5,212	400 0	47 0	35 4	22 1	25 5	22 6	26 6	27 0	26 10	
Pennland	1870	2,511	3,760	361 2	41 1	26 0	22 2	25 8	22 7	26 6	27 0	26 10	
Rhynland	1879	2,366	3,689	402 8	40 2	30 6	21 5	23 11	21 2	24 3	24 5	24 9	Jan. 29, 1890
Waesland	1867	3,054	4,752	435 1	41 9	29 9	21 10	25 6	22 1	26 6	27 3	27 0	Mar. 12, 1890
Westernland	1883	3,691	5,736	440 0	47 2	35 3	22 3	24 9	22 4	26 2	27 0	27 3	July 24, 1889
Zeeland	1865	1,850	2,866	337 1	42 9	27 7	20 3	22 8			23 10		
Belgenland	1878	2,364	3,692	402 9	40 2	30 6	21 4	24 7	21 10	24 8	26 6	25 0	
Richmond Hill Line.													
Richmond Hill	1882	2,703	4,126	420 0	47 0	26 5	17 3	22 11	17 2	23 6	23 10	23 10	Oct. 27, 1889
Nelson, Doukin & Co. Line.													
Florida	1882	2,644	3,138	336 6	41 2	26 5	18 0	24 6	24 0	24 6	24 6	24 11	Mar. 11, 1890
Ismailia	1888	1,940	3,008	337 0	41 2	26 5			23 10				
State Line.													
State of Indiana	1874	1,498	2,584	329 9	36 2	28 4	20 8	22 5	21 5	22 10	22 9	23 10	May 16, 1889
State of Georgia	1873	1,507	2,489	330 3	36 3	21 1 28 6	20 5	21 7	21 10	22 0	22 4	22 0	

State of Pennsylvania	1873	1,568	2,483	331 5	36 3	21 1	19 10	22 5	20 9	22 2	22 6	22 10	Dec. 19, 1889
St. Ronan's Steam-Ship Company.													
St. Ronan's	1881	2,916	4,457	402 0	43 4	24 9	22 6	25 5	23 4	25 1	26 0	26 2	May 10, 1889
Thingvalla Line.													
Hekla	1884	2,113	3,258	333 2	41 6	22 0	19 8	23 2	21 0	24 2	24 6	24 9	Mar. 8, 1890
Island	1882	1,818	2,844	315 0	34 0	21 4	18 4	22 5	22 6	23 0	23 0	23 0	July 27, 1889
Norge	.....	2,168	3,310	340 3	40 8	25 0	.....	.....	21 6	24 9	.....	25 6	Dec. 1, 1889 / Mar. 3, 1890
Thingvalla	1874	1,630	2,524	301 5	37 4	21 6 / 30 8	17 8	22 2	18 0	21 8	22 7	22 6	
White Cross Line.													
De Ruyter	.....	.....	.....	.....	.....	.....	19 2	21 4	.....	22 7	21 7	23 9	July 23, 1889
Hermann	1881	1,879	2,879	322 2	40 0	22 0	22 1	22 4	.....	23 2	23 8	23 6	
White Star Line.													
Adriatic	1871	2,458	3,888	437 2	40 9	31 0	21 6	24 7	22 2	24 7	25 3	25 1	
Arabic†	1881	2,788	4,368	430 2	42 2	31 5	.....	.....	.....	.....	.....	.....	
Baltic†	.....	.....	.....	.....	.....	.....	21 7	23 5	.....	.....	24 6	.....	
Britannic	1874	3,152	5,004	455 0	45 2	26 2 / 33 7	22 11	25 5	23 2	25 6	25 9	26 4	Mar. 19, 1890
Celtic	1872	2,439	3,867	437 3	40 9	23 4	23 2	25 2	22 5	24 8	26 0	25 3	
Cuñio	1888	3,055	4,639	430 7	45 2	30 0	.....	.....	19 6	24 3	.....	25 0	Aug. 16, 1889
Germannic	1874	3,150	5,008	455 0	45 2	33 7	22 11	24 11	23 3	25 7	26 5	25 11	
Republic†	1871	2,187	3,707	420 0	40 9	31 0	23 5	25 0	.....	.....	25 6	.....	
Runic	1889	3,046	4,649	430 3	45 2	30 0	.....	.....	20 5	24 7	.....	25 7	Jan. 3, 1890
Teutonic	1889	4,245	9,500	582 0	57 6	39 0	17 6	20 6	23 5	25 10	20 6	26 5	Mar. 5, 1890
Majestic	1889	4,340	9,500	582 0	57 6	39 0	.....	.....	.....	.....	.....	.....	
Williams Line.													
Frisia	1872	2,083	3,268	349 5	40 2	17 7	20 0	21 7	.....	.....	21 7	.....	
Wilson Line.													
Buffalo	1885	2,895	4,427	385 0	45 3	27 8	22 6	26 6	22 1	26 9	27 0	27 7	Aug. 17, 1889
Colorado	1887	2,787	4,220	370 0	44 7	28 4	.....	.....	22 1	26 8	.....	27 8	June 22, 1889
Egyptian Monarch	1880	2,552	3,916	360 0	43 1	24 8	20 9	24 7	20 6	24 9	24 8	25 4	Jan. 30, 1890
Hindoo	1889	3,037	3,592	367 1	42 8	31 2	.....	.....	20 11	25 6	.....	26 6	Sept. 1, 1889
Lydian Monarch	1887	2,595	3,987	360 0	43 0	24 8	24 0	24 1	*20 6	24 2	24 2	24 6	May 19, 1889
Martello	1884	2,439	3,709	370 0	43 1	28 4	20 5	25 10	22 4	26 0	27 0	27 7	Feb. 1, 1890
Persian Monarch	1880	2,565	3,923	360 0	43 1	32 6	22 6	25 1	21 1	24 3	25 1	25 0	

* Wrecked. † Sold to Dutch line.

Comparative statement of deep-draught steam-ships, for 1885 *and* 1889.

Year.	Steam-ships with draught of 26 feet and over.	Deepest draught.
		Ft. in.
1885	28	27 3
1889	44	28 4

Vessels belonging to the port of New York on the 30*th day of June,* 1889.

Class.	Number.	Tonnage.
Sailing vessels	2, 167	422, 664. 37
Steam vessels	1, 076	372, 896. 37
Canal-boats	208	21, 298. 34
Barges	631	129, 455. 27
Total	4, 082	946, 314. 35
Total for 1888	.....	915, 510. 58
Increase	.....	30, 803. 77

Vessels which have entered into and cleared from the collection district of New York for the year ending June 30, 1889.

	Entered.		Cleared.	
	No.	*Tons.*	*No.*	*Tons.*
American	1, 433	865, 459	1, 047	736, 875
Foreign	3, 599	4, 731, 362	3, 571	4, 717, 540
Total	5, 032	5, 596, 821	4, 618	5, 454, 415

Commercial statistics of the port of New York, for the fiscal year ending June 30, 1890.

Amount of revenue collected	$154, 831, 162. 38
Value of all imports	516, 364, 063. 00
Value of all exports	340, 268, 765. 00

	Number.	Registered tonnage.
Foreign vessels entered	3, 893	5, 268, 115
Foreign vessels cleared	3, 914	5, 239, 481
American vessels from foreign ports	1, 400	934, 507

Statement of the number and tonnage of all vessels belonging to the port of New York, for the fiscal year ending June 30, 1890.

	Number.	Registered tonnage.
Steam-vessels	969	352, 602. 58
Sailing vessels	1, 607	400, 897. 70
Barges	599	128, 003. 20
Canal-boats	24	3, 138. 37

REPORT OF FIRST LIEUTENANT HARRY TAYLOR, CORPS OF ENGINEERS, RESPECTING THE HEIGHT OF THE MASTS OF VESSELS OF THE LARGEST CLASS WHICH ENTER THE PORT OF NEW YORK.

ARMY BUILDING,
New York City, March 4, 1890.

SIR: In compliance with your letter of the 4th ultimo, I have the honor to submit herewith the following report in regard to the "height of the masts of the vessels of the largest class which enter the port of New York."

I have been able to get very little exact information on the subject. No measurements required by the custom-house or other authorities have anything to do with the masts, hence there is no official record that could be consulted. There are no definite, fixed rules, according to which vessels are rigged, but each is fitted, within certain limits, with masts and spars according to the fancy of the builder or rigger. Many of the captains do not have the exact measurements, so that even by boarding every vessel which entered the harbor the exact lengths could only be obtained from them by measuring—a very difficult operation. The exact measurements might be obtained by writing to the builders or riggers of the different vessels, but as the majority are built and rigged in foreign countries it would not be practicable to obtain the desired information about a sufficient number within any reasonable time.

It was necessary, therefore, to approximate to the heights, which was done in the following manner: From the custom-house I obtained the names and tonnage of all vessels which entered and cleared at the port of New York, both foreign and coastwise, during the month of January, 1890. From the Record (published by authority of the American Shipmasters' Association) I obtained the lengths, breadths, and depths of nearly all of these vessels. Then I got the opinions of practical riggers as to what lengths of masts these vessels would have, or, in other words, the lengths of the masts they would put on them if they were to rig them and were allowed to use their own discretion, the trade which the vessel would probably be engaged in being considered when anything was known, so that an opinion could be formed. While different riggers would vary the lengths of the masts of any particular vessel a little, the average was about the same. After computing them in this way I checked the results by boarding some of the vessels and obtaining the lengths of their masts where possible, and by finding the draughts of others with the men who had rigged them. Hence, while the height of the masts of any particular vessel may not be exact it is believed that on the average the heights are very close, and the table hereto appended gives a correct idea of the heights required:

Summary table.—Arranged according to heights of masts.

[Record for January, 1890.]

Height to truck (in feet, both inclusive).	No.	Height to truck (in feet, both inclusive):	No.
Not given	15	155-159	7
120-124	6	160-164	4
125-129	6	165-169	1
130-134	11	170-174	5
135-139	3	175-180	4
140-144	9		
145-149	13	Total	90
150-154	6		

	Main-mast.	Main-top mast	Truck.
Extreme height	86	125	180
Least height	67	91	120

All heights are estimated from the water when the vessel is light. Loaded, the heights would be from 10 feet to 15 feet less, according to the size and build of the vessel. Only vessels marked "S. S." are considered as having sky-sails. In nearly all ships the masts above the top-masts, although having three or four names, consist of one stick only, and any housing must be done at the topmast head.

The ship *Rappahannock*, recently built in Maine and now in Philadelphia, is one of the largest sailing vessels afloat, having a tonnage of about 3,100. According to a recent newspaper report the heights from the water to the top of her masts are, main-

mast, 87 feet; main-topmast, 129 feet; extreme height, 190 feet. These distances may safely be taken as the extreme heights of masts of vessels of the present day.

It was assumed that *no vessel under* 800 *tons would have masts over* 130 *feet* in height, and no vessels under that tonnage are included in the table. All steamers have comparatively short masts and need not be considered, since any bridge high enough for sailing vessels would not interfere with them.

As almost all schooners are employed in the coasting trade and do not enter or clear at the custom-house, the list shows no large schooners. But only a very few exceptionally large schooners have masts as high as 130 feet, and none, probably, reach 145 feet.

The number of sailing vessels of the different sizes that entered and cleared at the custom-house, port of New York, during January, is shown by the following summary:

Tonnage.	Foreign.				Coastwise.			
	Entered.	Cleared.	Total.	Per cent.	Entered.	Cleared.	Total.	Per cent.
Under 100	6	3	9	2.8	1	10	11	9.2
Over 100, under 200	35	40	75	23.3	7	14	21	17.6
Over 200, under 300	23	26	49	15.2	9	12	21	17.7
Over 300, under 400	10	21	31	9.6	7	14	21	17.6
Over 400, under 500	15	17	32	10.0	4	13	17	14.3
Over 500, under 600	12	14	26	8.1	3	3	6	5.0
Over 600, under 700	7	8	15	4.6	3	1	4	3.4
Over 700, under 800	3	5	8	2.5	.....	1	1	0.8
Over 800	34	43	77	23.9	7	6	13	10.9
Tonnage not given (barges)	.....	.....	.....	.....	2	2	4	3.4
Total	145	177	322	100	43	76	119	100

During the year 1889 there were 5,484 entrances, and clearances. During the six months, July to December inclusive, there were 518 coastwise entrances and clearances, or 1,036 during the year. Assuming the percentages of the different sizes to have been the same throughout the year as they were in January, the totals for the year would have been—

Entrances and clearances, 1889.

Tonnage.	Foreign.	Coastwise.	Total.
Under 100	154	95	249
Over 100, under 200	1,278	182	1,460
Over 200, under 300	834	183	1,017
Over 300, under 400	526	182	708
Over 400, under 500	548	148	696
Over 500, under 600	444	52	496
Over 600, under 700	252	35	287
Over 700, under 800	137	9	146
Over 800	1,311	113	1,424
Tonnage not given (barges)	.....	35	35
Total	5,484	1,036	6,520

Assuming that the 75 vessels in the summary table, which are classified according to the height of their masts, represent all those over 800 tons which entered and cleared at the port of New York, we should have for the whole year of 1889—

Height to truck (in feet).	No.	Height to truck (in feet).	No.
120 to 124	114	155 to 159	133
125 to 129	114	160 to 164	76
130 to 134	209	165 to 169	19
135 to 139	57	170 to 174	95
140 to 144	171	175 to 180	76
145 to 149	246		
150 to 154	114	Total	1,424

Considering all sailing vessels which entered and cleared at the custom-house during 1889, we have—

Height of bridge above water.	Number of vessels that would be interfered with.	Per cent. of total number entering and clearing.
120	1,424	21.9
125	1,310	20.1
130	1,196	18.4
135	987	15.1
140	930	14.3
145	759	11.6
150	513	7.9
155	399	6.1
160	270	4.0
165	194	2.9
170	175	2.6
175	76	1.2

Although the percentages of the number of vessels that would be interfered with are here shown, this does not show the percentages of the tonnage, for generally, the higher the masts the larger the vessel, and consequently the percentage showing the *tonnage* which would be interfered with by a bridge of any given height would be from two to four times as large as that representing the *number* of vessels that would be interfered with by the same bridge.

But it must be remembered that I have not considered sailing vessels that do not enter or clear at the custom-house, nor any steamers. There were about 8,500 entrances and clearances of steamers in 1889, and as the average tonnage of these was far larger than that of the sailing vessels, it is probable that their tonnage aggregated at least five times as much. There are also the sailing vessels not entered. These would also add to the aggregate not interfered with.

Hence, while to get at the per cent. of the entire tonnage of the harbor interfered with by a bridge of any particular height, from the per cent. of the *number* as given above, we should have to multiply it by a factor between two and four on account of the greater tonnage of the vessels having higher masts; we should also have to divide by another factor of at least five and five-tenths on account of the vessels not considered, and which would not be interfered with.

Very respectfully, your obedient servant,

HARRY TAYLOR,
First Lieut. of Engineers.

Lieut. Col. G. L. GILLESPIE,
Corps of Engineers, U. S. A.

APPENDIX.

List of the sailing vessels over 800 tons which entered and cleared at the custom-house, port of New York, January, 1890.

FOREIGN ENTRANCES, JANUARY, 1890.

Flag.	Rig.	Name.	Tonnage.	Length.	Breadth.	Depth.	Height to top of— Mainmast.	Main-top mast.	Truck.
				Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Italian	Bark	Agostino Rombo	807	155.1	30.5	21.6	67	91	120
American	do	Adam W. Spies	1,171	185.0	38.4	22.8	75	107	157*
Dutch	Ship	Alice	1,333	(†)	(†)	(†)	(†)	(†)	(†)
Norwegian	Bark	Alice	935	168.7	35.6	22.5	70	100	133
British	do	Annie Stafford	1,297	199.0	38.4	23.5	77	109	145
Do	do	Argyll	1,273	197.4	38.3	22.9	77	108	145
Do	do	Bristol	1,305	192.8	39.1	23.6	78	110	147
German	do	Charles Lüling	1,231	194.4	39.0	23.7	78	108	146
American	Ship	City of Philadelphia	1,384	202.3	40.3	24.3	80	112	158
Norwegian	Bark	C. Tobias	830	159.6	32.9	18.7	67	92	123
German	Ship	Deutschland	1,251	193.8	38.3	23.6	79	109	145
Do	Bark	D. H. Wätjen	1,215	178.0	37.0	28.0	80	109	146
American	do	E. W. Stetson	1,106	173.2	38.2	23.6	78	106	142
Do	Ship	Exportes	1,312	199.5	38.2	24.0	82	109	146
British	do	Glaucus	1,999	(†)	(†)	(†)	(†)	(†)	(†)
Belgian	do	Hainant	1,709	248.6	40.3	22.1	84	117	164*
American	Bark	James A. Wright	887	196.0	36.0	20.0	70	100	145*
British	do	Lancefield	994	179.0	36.5	21.5	73	104	135
Do	do	Latona	948	192.0	36.5	20.2	72	103	134
Do	Ship	Mabel Taylor	1,298	205.0	37.7	22.9	75	105	140
Italian	do	Mania Raffo	1,309	(†)	(†)	(†)	(†)	(†)	(†)
American	Bark	Mohican	814	160.2	35.2	19.9	72	102	132
Italian	do	Nemesis	1,061	(†)	(†)	(†)	(†)	(†)	(†)
American	do	Normandy	1,166	188.0	38.0	24.2	80	109	144
British	Ship	Orchomene	1,542	239.0	37.3	22.7	80	113	148
Do	do	Pythomene	1,896	265.6	39.7	24.1	83	117	153
American	Bark	Richard Parsons	1,116	189.4	37.2	23.2	73	106	140
Do	Ship	Sam Skolfield, 2d	1,514	218.7	39.9	24.2	79	114	155
British	Bark	Strathay	1,024	183.0	33.8	22.5	70	100	132
Do	Ship	Sultan	1,323	203.1	40.0	23.9	78	114	153
German	do	Theordor Fisher	1,784	213.0	42.2	29.9	84	120	175*
British	Bark	Violet	846	161.8	33.4	19.0	67	96	128
American	Ship	Wachusett	1,519	214.0	40.2	26.4	80	115	156
British	do	Walter H. Wilson	2,461	308.1	42.8	24.9	83	118	173*

FOREIGN CLEARANCES, JANUARY, 1890.

Italian	Bark	Agostino Rombo	807	155.1	30.5	21.6	67	91	120
Norwegian	do	Alice	935	168.7	35.6	22.5	70	100	133
German	Ship	Anna	1,159	171.9	30.5	19.7	67	92	124
British	do	Assyria	1,148	189.1	36.7	22.5	73	106	140
Do	Bark	Athlon	1,371	188.0	39.5	24.0	78	110	148
German	Ship	Baltimore	1,081	184.0	36.0	22.0	75	104	138
British	Bark	Bristol	1,305	192.8	39.1	23.6	78	110	147
Do	Ship	C. of Athens	1,199	(†)	(†)	(†)	(†)	(†)	(†)
Norwegian	Bark	Carte Blanche	830	163.3	31.4	19.7	67	91	121
British	Ship	Ceylon	944	179.5	36.5	22.1	72	105	138
German	do	Columbus	1,731	213.6	40.8	28.6	84	119	173*
Norwegian	Bark	Dagney	992	173.0	35.0	21.0	69	98	130
American	Ship	Eclipse	1,536	221.7	40.3	24.3	80	114	167*
German	do	Elise	1,348	192.5	39.9	24.6	80	113	154
Norwegian	Bark	Faust	811	164.8	35.5	18.6	68	97	128
British	4-mast ship.	Falls of Halladale	2,026	275.5	41.6	23.9	84	117	170*
Austrian	Bark	Filadilfia	830	163.6	31.8	21.0	68	92	122
Hawaiian	do	Foohng Suey	989	(†)	(†)	(†)	(†)	(†)	(†)
German	Ship	Friederike	1,398	204.3	40.0	24.1	81	117	155
Do	do	Friedlander	1,584	215.8	39.4	26.4	81	118	155
Do	Bark	Geo. Washington	1,185	191.2	37.3	23.2	77	108	143
Do	do	Goschen	1,137	171.7	37.9	23.4	77	108	143
British	do	James Stafford	1,117	178.0	38.0	22.9	77	110	145
Norwegian	Ship	Josephine	873	161.7	33.1	21.6	67	96	130
Do	Bark	Julie	850	167.0	34.7	20.3	67	96	130
British	do	Lynnwood	1,150	190.2	38.0	22.7	76	109	144

List of the sailing vessels over 800 tons which entered and cleared at the custom-house, port of New York, January, 1890—Continued.

FOREIGN CLEARANCES, JANURY, 1890—Continued.

Flag.	Rig.	Name.	Tonnage.	Length.	Breadth.	Depth.	Height to top of— Mainmast.	Main-top mast.	Truck.
German	Ship	Magdalene	1,250	196.8	39.8	22.9	78	114	150
Do	Bark	Mare Siedenberg	1,143	(†)	(†)	(†)	(†)	(†)	(†)
British	Ship	Mary S. Burrill	1,456	(†)	(†)	(†)	(†)	(†)	(†)
American	Bark	Matanzas	977	(†)	(†)	(†)	(†)	(†)	(†)
British	do	Minnie G. Whitney	1,222	191.8	38.7	23.8	78	110	146
Do	Ship	Mohur	1,413	207.0	39.9	23.8	80	116	153
Do	S. Ship	Narwahs	1,328	204.0	39.0	23.7	78	114	151
Do	Bark	Ordovic	825	168.6	33.8	21.3	66	94	127
American	do	Pilgrim	918	172.4	35.0	21.0	70	100	132
British	do	R. Morrow	1,156	188.7	37.6	22.2	76	107	142
Russian	Ship	Rhea	968	215.8	41.6	21.3	78	113	163
British	Bark	Routenbeck	930	208.5	32.3	19.5	66	94	128
Do	Ship	Scottish Isles	1,998	(†)	(†)	(†)	(†)	(†)	(†)
German	Bark	Senator J. Kerr	1,247	(†)	(†)	(†)	(†)	(†)	(†)
British	Ship	W. B. Lewis	1,325	(†)	(†)	(†)	(†)	(†)	(†)
Do	do	Warsaw	1,347	203.6	29.0	26.3	79	115	156
Do	do	Wynnstay	1,601	258.8	38.2	23.1	80	115	160

COASTWISE ENTRANCES, JANUARY, 1890.

	Ship	Godiva	1,999	(†)	(†)	(†)	(†)	(†)	(†)
	do	J. B. Thomas	1,851	(†)	(†)	(†)	86	125	175*
	do	Jay	1,181	(†)	(†)	(†)	(†)	(†)	(†)
British	Bark	Mary A. Troop	1,118	189.2	34.1	22.3	66	94	128
American	Ship	Tacoma	1,672	222.2	41.0	25.9	85	123	178*
	do	Tolga	1,620	(†)	(†)	(†)	(†)	(†)	(†)
Holland	Bark	Tjermai	1,013	188.2	36.7	21.1	70	100	133

COASTWISE CLEARANCES, JANUARY, 1890.

American	Ship	A. J. Fuller	1,782	229.3	41.5	26.0	82	118	172*
Do	do	C. Southerd Hurlbert	1,036	178.6	35.7	21.2	69	98	131
British	do	Fred B. Taylor	1,798	237.0	42.0	24.0	81	117	160
American	do	S. P. Hitchcock	2,178	247.4	44.3	28.6	83	120	180*
Do	Bark	Saranac	1,027	195.5	34.6	22.5	68	96	129
Do	Ship	Undaunted	1,722	207.3	41.1	27.8	81	117	171*

* Carries sky-sails. † Not in the Record.

E 10.

IMPROVEMENT OF RARITAN BAY, NEW JERSEY.

Raritan Bay forms the western part of the large triangular bay inclosed between Sandy Hook, the New Jersey shore, and Staten Island, the eastern part of which is commonly known to New Yorkers as the Lower Bay, as it lies just outside of, or below, New York Harbor, which is the name usually applied to the inner body of water on which the city of New York is situated.

The Raritan River flows into Raritan Bay at its extreme western end, passing between Perth Amboy and South Amboy, and Newark Bay is connected with both the Raritan River and Bay by the Arthur Kill, or Staten Island Sound, which, separating Staten Island, belong-

ing to the State of New York, from the Jersey shore, enters Raritan Bay at Perth Amboy.

The depth of the bay varies from 5 to 30 feet, decreasing gradually towards its western and southern shores.

The natural channel leading out of it, after passing the Great Beds Light at the junction of Staten Island Sound and the Raritan River, does not follow the middle of the bay, but hugs the Staten Island shore for nearly 4 miles to Seguine's Point, situated about half a mile east of Prince's Bay Light, then it runs southeastwardly towards the inner point of Sandy Hook about 2 miles, crossing a shoal which puts out towards the southward from the Staten Island shore.

In 1880, before any improvement had been made here by the Government, 18 feet at mean low water could be carried through from Perth Amboy to Great Beds Light; while there was not less than 21 feet of water from Great Beds Light to Seguine's Point to deep water in the outer bay, only 14½ feet of water could be carried across the shoal.

The width of this shoal between the 21-foot curves was about 8,000 feet.

Through the middle of the bay, south of this channel from Great Beds Light directly towards Sandy Hook, only 11 feet of water could be carried over the shoals.

The above depths all refer to mean low water.

A survey of this bay was ordered in 1880, with the view of ascertaining the practicability of securing a greater depth of water from the main ship-channel in the lower bay to the wharves at Perth Amboy, as vessels were often much delayed in crossing the shoal east of Seguine's Point.

The estimated cost of dredging a channel 300 feet wide and 21 feet deep, mean low water, from Seguine's Point southeastward to the deeper waters of the bay outside was $126,500. (Annual Report Chief of Engineers, 1881, Part I, pages 717–719.)

From March 3, 1881, to July 5, 1884, $120,000 were appropriated for this improvement, and a survey which was made in May, 1885, showed that the improved channel at that date had an average width of 250 feet, and a least depth of 18 to 20 feet, mean low water.

The channel had slightly shoaled since the dredging was suspended in 1884. In 1885 the project was extended by providing for excavating a channel 300 feet wide and 21 feet deep, from Great Beds Light to deep water at Ward's Point, opposite Perth Amboy. This channel, taken in connection with the one to be dredged outside of Seguine's Point, would give a continuous 21-foot channel from the main ship-channel in New York Bay to the wharves at Perth Amboy. The modified project of 1885 further called for dredging a channel from Great Beds Light to South Amboy, 4,500 feet long, 300 feet wide, and 15 feet deep, mean low water. The cost of dredging these two channels and restoring the original width in the cut east of Seguine's Point was estimated to cost $114,000, which sum was increased in 1888 to $120,000, to provide for the shoaling which had taken place in the interval of three years. (Annual Report Chief of Engineers, 1885, Part I, page 758.) The appropriation, act of August 5, 1886, was $37,500, and was applied to completing the channel west of Ward's Point, 300 feet wide and 21 feet deep, and in excavating a channel 315 feet wide and 21 feet deep across the crest of the shoal leading from the bend toward Seguine's Point, but the funds were not sufficient to complete the whole of the projected work at that point.

It was stated in the original project of 1881 that the Seguine's Point

Channel would have to be maintained by dredging. The detailed survey which was made in 1888, from the eastern end of the Seguine's Point Channel to Perth Amboy, showed that considerable shoaling had taken place both in the improved channel and over a large stretch west of Prince's Bay Light, where deep water formerly existed. This fact made it necessary, in 1889, to submit revised estimates for the further improvement of the channels leading to Perth Amboy and to South Amboy. (Annual Report Chief of Engineers for 1889, Part I, page 796.)

REVISED ESTIMATES.

	Cubic yds.
1. For a channel 300 feet wide and 21 feet deep, mean low water, from New York Lower Bay, to Perth Amboy, the following dredging will be required:	
(a) From 21-foot curve, New York Lower Bay, to 31-foot curve off Seguine's Point	347,368
(b) From Prince's Bay around Red Buoy 8, towards Great Beds Light	154,130
Total dredging	501,498
2. For a channel 300 feet wide and 15 feet deep from Great Beds Light to South Amboy, the dredging required will be	200,000

These estimates are made on the basis of an allowance of 1 foot over depth, and for one-third increase in bulk for scow measurement.

Total dredging required for the completion of the two projected channels, cubic yards	701,498
Estimated cost of the proposed dredging	$175,375

The river and harbor act of August 11, 1888, appropriated $25,000 for continuing the improvement, and on the 27th of February, 1889, contract was made with James A. Simmons, of New York City, for the removal of 120,000 cubic yards of material from Raritan Bay; 80,000 cubic yards to be removed from the channel across the shoal off Seguine's Point, securing 21 feet depth; and 40,000 cubic yards from the channel leading across shoal at Great Beds Light to South Amboy, securing 15 feet depth, mean low water.

WORK DONE DURING THE FISCAL YEAR.

Operations under the contract with Mr. Simmons began August 27, with two dredges—one dredge working in each channel.

The removal of the quantity allotted to the channel from Great Beds Light to South Amboy was completed October 22, resulting in a channel from 70 to 80 feet wide and 15 feet deep, mean low water. The channel so improved, though somewhat limited in width, has afforded much-needed relief to the large tows which come from the Raritan River.

The removal of the quantity allotted to the channel east of Seguine's Point was not completed till June 12, resulting in a channel 100 feet wide and 21 feet deep between the head of Raritan Bay and the deep-water channel along the south side of Staten Island.

Some complaint has been made by the oystermen that the execution of this contract has injured their oyster-beds; while the complaint is in a degree well founded, there is no practicable way of remedying it. Every precaution has been taken to protect the oyster-beds adjacent to the channel, even allowing the contractor to moor his scows at times in the channel itself while awaiting an opportunity to go to sea, and it is believed that the damage to the oyster-fields has been ideal rather than actual.

No work has been done on the channel from Ward's Point to the 21-foot curve near Seguine's Point since June 15, 1888. At that date the channel was 300 feet wide and 21 feet deep from the wharves at Perth Amboy to the bend at Great Beds Light, and across the crest of the shoal leading from the bend to Seguine's Point the channel was 300 feet wide and 20 feet deep.

Harbor lines for the south shore of Staten Island from Fort Wadsworth to Ward's Point and thence north along the east bank of Arthur Kill to opposite Elizabethport, and from Elizabethport south along the west bank of Arthur Kill to Perth Amboy, were established by the Secretary of War March 4, 1890. The Harbor Line Board has also recommended for approval lines extending from Perth Amboy westward along the left bank of the Raritan River to the head of Crab Island, and thence eastward along the right bank to South Amboy, and thence eastward to Cheesequakes Creek.

An appropriation of $100,000 is recommended for continuing the improvement along the channels leading to Perth Amboy and to South Amboy, respectively.

This work is in the collection district of Perth Amboy, which is the nearest port of entry. Nearest light-house, Prince's Bay; nearest fort, fort at Sandy Hook, New Jersey.

Amounts appropriated.

Date.	Application.	Amount.
Mar. 3, 1881	Dredging	$50,000
Aug. 2, 1882	....do	50,000
July 5, 1884	....do	20,000
Aug. 5, 1886	....do	37,500
Aug. 11, 1888	....do	25,000
	Total	182,500

Amount expended to June 30, 1890, inclusive of outstanding liabilities, $180,560.28.

Money statement.

July 1, 1889, amount available	$3,197.42
July 1, 1890, money value of work done during the fiscal year under contracts made prior to June 30, 1889	22,200.00
	25,397.42
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	23,457.70
July 1, 1890, balance available	1,939.72
Amount appropriated by act of September 19, 1890	40,000.00
Amount available for fiscal year ending June 30, 1891	41,939.72
Amount (estimated) required for completion of existing project	135,375.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	100,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

The following statement of the commerce of South Amboy, N. J., and of Raritan River, was prepared by Hon. D. C. Chase, mayor of South Amboy, N. J.

Receipts and shipments.

Articles.	Quantity.
	Tons.
Products of the forests	33, 851
Products of quarries and mines	3, 020, 003
Animal products	16, 541
Agriculture	37, 557
Manufactures	417, 909
Mechanical and miscellaneous	320, 005
Total	3, 845, 866

Total value, $45,075,943.

Vessels arriving and departing.

Class.	Number.	Tonnage.	Draught (loaded).
			Feet.
Steamers	6, 038	359, 300	6 to 12
Barks	40	8, 800	8 16
Brigs	40	8, 800	8 16
Schooners	4, 138	248, 280	7 14
Sloops	1, 002	52, 210	5 7
Propellers	4, 028	280, 682	7½ 10
Barges and lighters	45, 838	2, 887, 794	7 16
Total	61, 124	3, 845, 866	.....

The following statement of the commerce of Perth Amboy, N. J., for the year 1889, was received from Mr. James Donnelly, superintendent of the New Jersey Division, Lehigh Valley Railroad Company:

Lehigh Valley Railroad tonnage eastward and westward over the wharves for the year 1889.

	Received.	Shipped.	Total.
Coal piers.	*Tons.*	*Tons.*	*Tons.*
Coal	.....	1, 815, 521	
Coke	.....	3, 058	
			1, 818, 579
Freight wharves.			
Grain	.....	125, 743	
Steel rails	.....	34, 052	
Pig-iron	471	87, 796	
Iron ore	86, 194	.....	
Lumber	33, 207	875	
Fertilizer	106	.....	
Clay	.....	5, 602	
Miscellaneous	5, 867	7, 732	
			387, 705
United Refiners Export Oil Company's wharf.			
Oil	.....	60, 867	60, 867
Grand total	.....	.....	2, 267, 151

Number, tonnage, and draught of vessels.

	Number.	Tonnage.	Draught.
Vessels transporting coal:			
Steam	102	500 to 3, 000	.....
Sailing	848	50 1, 200	.....
Barges	311	500 1, 200	.....
Boats	4, 821	100 400	.....
Vessels transporting freight:			
Ocean steamers	10	1, 500 3, 500	19 to 23.5
Sailing vessels	181	500 1, 200	15 18
Lighters	57	200 500	6 13
Canal-boats	1, 238	200 300	6
Vessels transporting oil from Oil Company's wharf:			
Barks and ships	59	500 1, 500	15 18

E 11.

PRELIMINARY EXAMINATION OF WAPPINGER'S CREEK FROM WAPPINGER'S FALLS TO ITS MOUTH, NEW YORK.

ENGINEER OFFICE, U. S. ARMY,
New York, N. Y., October 25, 1888.

GENERAL: In compliance with Department letter of September 29, 1888, I have the honor to submit the following report on the preliminary examination of Wappinger's Creek from Wappinger's Falls to its mouth:

Wappinger's Creek is a small stream emptying into the Hudson River just below New Hamburgh. It is navigable at high tide for vessels drawing 7 feet or less from its mouth to Wappinger's Falls, a distance of about 1¾ miles. The range of the tide is about 3 feet.

The improvement desired consists in providing and maintaining a channel 60 feet wide and 8 feet deep at mean low water to the head of navigation at Wappinger's Falls.

This small manufacturing town owes its prosperity primarily to the water-power derived from the falls, which has been utilized for the establishment of the extensive print-works of the Dutchess Company, which gives employment to the bulk of the population of the town. This population amounts to 5,000 people, and about 2,000 residents of the surrounding country would also be more or less benefited by the proposed improvement. The nearest railroad station is at New Hamburgh, about 2 miles distant, and most of the supplies of the place are brought from there by water on Wappinger's Creek. The receipts of coal, building material, and general merchandise, with the shipments of the product of the print-works, make up a total estimated tonnage of about 67,000 tons per annum.

It is probable that in addition to dredging the proposed channel some dike work would have to be done to maintain it against the effects of the annual freshets in the stream. As far as I am able to judge without more complete data the work should be done for about $30,000.

Wappinger's Creek is worthy of improvement, and I estimate the cost of the survey at $700.

I should mention the fact that it is estimated that five-sixths of the tonnage on the creek goes to, or is shipped by, the Dutchess Company's print-works, and that heretofore the dredging on the creek, of which there has been considerable, has been done by that company. They will undoubtedly be the principal beneficiaries if the creek is improved by the General Government, and could probably well afford to continue to improve the stream at their own expense. But, on the other hand, the whole town of Wappinger's Falls is interested in the prosperity of this concern, which furnishes a large amount of employment, and is the main support of the place; and, besides, the estimated tonnage of the creek going to parties not connected with the print-works is considerable, amounting to about 11,000 tons.

Very respectfully, your obedient servant,

GEO. MCC. DERBY,
Captain of Engineers, in Temporary Charge.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

SURVEY OF WAPPINGER'S CREEK, NEW YORK, FROM WAPPINGER'S FALLS TO ITS MOUTH.

ENGINEER OFFICE, U. S. ARMY,
New York, N. Y., November 11, 1889.

GENERAL: In obedience to instructions contained in your letter of April 1, 1889, I have the honor to submit a report on the survey of Wappinger's Creek, New York, from Wappinger's Falls to its mouth, to comply with the requirements of the river and harbor act of August 11, 1888.

Wappinger's Creek is a small stream which rises in the northern part of Dutchess County, N. Y., near the boundary with Columbia County, and after flowing for about 40 miles through a rich and fertile valley, empties into the Hudson River on the east bank, one-half mile below the village of New Hamburgh, N. Y.

It is navigable for boats and scows drawing not over 6 feet in a channel varying in width from 25 to 75 feet, to Wappinger's Falls, 2 miles, approximately, above its mouth, where a series of falls, with an aggregate height of 86½ feet above mean low water, furnish a valuable water-power for three industries, the principal of which is the print-works of the Dutchess Company.

At the entrance the width of the channel is 100 feet, approximately, and the depth 7 to 8 feet, mean low water. The stream is subject to an annual freshet which raises the level of the water not exceeding 10 feet.

The commerce which is carried over the short navigable reach of 2 miles amounts to 70,000 tons, approximately, annually, and has an estimated valuation of $6,500,000. The principal part of this commerce originates with the Dutchess Company, who own the falls and the water-power.

Very little of the tonnage attributed to the stream goes beyond the immediate mouth of the river, as it is understood that the Dutchess Company makes with the New York Central Railroad annual rates for transportation along its line of all freight delivered at New Hamburgh.

The vessels and scows which come from outside ports belong to the smaller class, are very few in number, and carry in and out a limited amount of tonnage.

The general features of the stream and the character of the industries at Wappinger's Falls are given in the accompanying report of Mr. Charles G. Weir, assistant engineer.

There are no engineering difficulties which prevent a ready improvement of the creek to the head of navigation. The general course of the creek is regular, and the bed is composed chiefly of soft mud, which can be easily removed by the ordinary dredge.

It is estimated that 45,000 cubic yards of material are required to be removed to make a navigable channel 80 feet wide and 8 feet deep, mean low water, from Wappinger's Falls to the mouth, at an estimated cost of $13,000, viz:

Excavating 45,000 cubic yards of material, at 25 cents	$11,250
Expenses of engineering and surveying	1,750
Total estimated cost	13,000

It is true that the town of Wappinger's Falls is dependent upon the few industries which are maintained by the water-power of the falls, and is in a measure benefited by the limited commerce of the creek upon whose banks it is located; still I do not feel justified in recommending

that the General Government should make an appropriation for improving a stream whose natural conveniences are equal to the meager demands made upon it by commerce in general, and whose local commerce has little prospect of increasing in the near future to a degree which warrants an improvement at this time of the existing navigable channel at Government expense.

This part of the Hudson River is in the collection district of New York, and the nearest light-house is located in Danskammer Point.

The nearest port of entry is New York.

Very respectfully, your obedient servant,

G. L. GILLESPIE,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. CHARLES G. WEIR, ASSISTANT ENGINEER.

ENGINEER OFFICE, U. S. ARMY,
New York, N. Y., November 4, 1889.

COLONEL: I have the honor to submit the following report, with accompanying map,* of the survey of Wappinger's Creek, New York. The triangulation was made in October, 1888, and the survey completed in August of this year.

Wappinger's Creek is a tributary of the Hudson River, and enters it on the east side about 65 miles above New York City, and 57 miles below the city of Albany, and half a mile south of the village of New Hamburgh.

The Hudson River Railroad crosses the creek at its mouth, where is located a draw-bridge, the width of the draw being 27 feet. Above this draw about 350 yards is another-draw bridge where a wagon-road crosses.

The creek is navigable for a distance of a mile and three-quarters above the railroad bridge. Above this for a distance of 2,000 feet are a series of falls and rapids, the total height of which is 86¼ feet above the plane of mean low water.

At the head of navigation is located the town of Wappinger's Falls, which is a manufacturing place of some importance, containing a population of 5,000, 6 manufactories, and 49 stores, the factories in part being run by the water-power taken from the creek.

The principal manufactures are cotton goods, overalls, clothing, combs, and iron. This is mostly freighted by boats to the mouth of the creek, inside of the railroad bridge, where it is transferred to the Hudson River Railroad.

The tonnage of merchandise taken through the creek during the year 1888 exceeded 70,000 tons, part of which, principally coal, lumber, and building material, was incoming. The value of the tonnage exceeded $6,500,000. The Dutchess Company alone shipped 15,500 tons of cloth, valued at $5,600 000; 20,000 tons of coal, of value $80,000; and 2,000,000 feet of lumber, worth $40,000.

This company employs 1,000 hands.

During the year 1888 the railroad draw was opened 896 times, and the other draw, known as Drake's draw, was opened 2,300 times during the same year. The traffic is principally carried on by sloops, schooners, scows, canal-boats, and tugs. No regular freight or passenger line is now running to points on the river or to New York City from Wappinger's Falls. Formerly there was a line to New York City, which was abandoned on account of the difficulty of the channel. The present channel is quite narrow in places, varying from 20 feet to 100 feet between the 6-foot curves, and the character of the bottom is mostly soft mud. The rise and fall of the tide is 2.89 feet.

A channel 80 feet wide and 8 feet deep would amply accommodate traffic. To make such an improvement would involve the removal by dredging of 45,000 cubic yards of material, which, at a cost of 25 cents per yard, would be $11,250, and 10 per cent. for contingencies (pay of inspectors, etc.), would make an aggregate cost of $13,000.

Respectfully submitted.

CHARLES G. WEIR,
Assistant Engineer.

Lieut. Col. G. L. GILLESPIE,
Corps of Engineers.

---

* *Omitted*; printed in House Ex. Doc. No. 25, Fifty-first Congress, first session.

E 12.

PRELIMINARY EXAMINATION OF EAST RIVER, WITH A VIEW TO THE REMOVAL OF A LEDGE OF ROCKS IN THE SAME, FROM THE FOOT OF BROOME STREET TO THE FOOT OF TWENTY-THIRD STREET, IN NEW YORK CITY.

ENGINEER OFFICE, U. S. ARMY,
New York, N. Y., October 25, 1888.

GENERAL: In compliance with Department letter of September 29, 1888, I have the honor to submit the following report on the preliminary examination of the East River, with a view to the removal of a ledge of rocks in the same, from the foot of Broome street to the foot of Twenty-third street, in New York City.

The westerly side of the channel of the East River from Broome street to Twenty-third street, New York City, a distance of about 1½ miles, is obstructed in many places with reefs, some of which extend into the channel as much as 1,000 feet from the pier line. The principal one of these, known as Shell Reef or Tenth Street Reef, has a depth of only 7¾ feet on its crest. It is not known to what extent these reefs consist of solid rock, some of them being largely composed of bowlders bedded in clay.

It is therefore impossible to form an opinion as to the approximate cost of their removal; it would undoubtedly be several hundred thousand dollars and might run into the millions.

None of these reefs are very dangerous, as there is a deep channel more than 1,000 feet wide to the eastward of them, and their removal is by no means so urgent as the completion of the work already begun for the improvement of East River and Hell Gate. Nevertheless they are obstructions to navigation such as should not be permitted to remain in the crowded channels of New York Harbor. They should be surveyed, and their removal to such depth as may be thought necessary should form part of the project for the improvement of East River and Hell Gate, though operations should not actually be begun on them until work more urgently required is completed.

It is unfortunate that the upper limit of the survey was not set at Fiftieth street instead of Twenty-third street, as there are more dangerous reefs above Thirty-third street.

The East River from Broome street to Twenty-third street is worthy of improvement, and the cost of the survey is estimated at $2,000.

Very respectfully, your obedient servant,

GEO. MCC. DERBY,
Captain of Engineers, in temporary charge.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

SURVEY OF EAST RIVER, WITH A VIEW TO THE REMOVAL OF A LEDGE OF ROCKS IN THE SAME, FROM THE FOOT OF BROOME STREET TO THE FOOT OF TWENTY-THIRD STREET, IN NEW YORK CITY.

ENGINEER OFFICE, U. S. ARMY,
New York, N. Y., January 24, 1890.

GENERAL: I have the honor to submit the following report on a survey of the East River near the foot of Broome street to the foot of

Twenty-third street, New York City, made to comply with the river and harbor act of August 11, 1888, which provides for a survey of—

The East River (New York), with a view to the removal of a ledge of rocks in the same, from the foot of Broome street to the foot of Twenty-third street, in New York City. This survey to be made notwithstanding any other survey heretofore made.

The preliminary report on this survey by the engineer officer in local charge, dated October 25, 1888, stated that the river between the limits defined in the act was worthy of improvement, and the survey was accordingly authorized to be made by Department letter dated April 1, 1889.

The survey was completed in September, but the borings, owing to unavoidable delays, were not completed till December.

The river and harbor act of August 6, 1886, contained a provision for a survey of a portion of this reef, consisting of a "ledge of rocks situated between 500 and 600 feet from the foot of Tenth and Eleventh streets," and the report thereon of the engineer officer, dated January 28, 1887, will be found on page 758 of the Annual Report of the Chief of Engineers for 1887. The Coast Survey charts covering the alleged obstructions were stated at that time to be in so much detail that a new survey was not recommended until provision was made for a general survey of the reefs extending from Blackwell's Island to Seventh street, New York.

Assuming the surroundings on the Coast Survey charts to be correct, the cost of removing the reef opposite Tenth street to the grade of 15 feet below mean low water was estimated at $300,000, and to the grade of 20 feet, $800,000. The cost of removal of the material was assumed at $10 per cubic yard.

The present survey, it will be observed, covers the entire reef from Grand street to Twenty-third street. The reef is 8,300 feet long, following the shore line, and its maximum width, exterior to the pier line opposite Tenth street, is 1,100 feet. The average width of the reef beyond the pier line, between the extreme limits of the survey, is 700 feet, and the average depth of water varies only slightly from 18 feet, mean low water.

The material of the bottom is composed of a covering of sand, gravel, and bowlders resting upon a bed of clay, through which solid rock projects at one point, forming the nucleus of a hard and dangerous shoal.

The highest point of the reef, known locally as Shell Reef, lies opposite Tenth street, and its crest, which has a least depth of 9 feet, mean low water, over a very small area, is 600 feet east of the pier line at the foot of that street.

Shell Reef, within the 15-foot curve, extends north and south 900 feet, and east and west 600 feet. Its western edge is 275 feet distant from the pier line at the foot of Ninth street, from which it is separated by a 20-foot channel near the pier line, 150 feet wide, approximately. Its eastern edge is 1,250 feet distant from the pier line on the Brooklyn side, over which for a distance of 1,100 feet, approximately, estimated from that pier line, the least depth exceeds 40 feet, mean low water, the maximum depth bengi 62 feet.

Shell Reef divides the main reef into two nearly equal parts; the part lying to the northward is deeper than the part lying to the southward, and the material of the bottom, as determined by the borings, is of less difficult removal. While it is probable that Shell Reef itself is composed partly of solid rock and partly of bowlders and gravel resting upon hard clay, and will require more or less blasting for its removal, it is fair to suppose from the character of the borings that the

bed at other points, north and south, on the reef is composed of less serious material, whose removal will be made expensive mainly by the violent action of the currents.

The distance between the pier lines of the two banks of the East River at Thirty-third street ferry is 2,780 feet, and the area of cross-section 103,485 square feet; at Twenty-first street the distance is 2,330 feet, and the area of cross-section 82,736 square feet; at Ninth street the distance is 2,220 feet, and the area of cross-section 74,141 square feet; at Houston street the distance is 1,490 feet, and the area of cross-section 48,351 square feet; at Corlear's Hook the distance is 1,600 feet, and the area of cross-section 78,265 square feet; at Jackson Square the distance is 1,350 feet, and the area of cross-section 51,337 square feet; and at Peck Slip, not shown on the accompanying chart, the distance is 1,310 feet, and the area of cross-section 59,275 square feet.

The foregoing dimensions call attention to the very prominent gorge which exists at Houston street, formed not only by a noticeable shoal with a least depth of 17.7 feet adjacent to the north bank, but also by the recession of both banks, east and west, from this point.

The sudden contraction of the water-way here noted must necessarily be the cause of the excessive tidal velocities, which have been observed to be about 4 nautical miles per hour through the Houston street cross-section. But as both banks are now permanent, and as the area of the cross-section at this gorge is only about two-thirds of that at Corlear's Hook on the south, or at Tenth street on the north, no other relief can be given to existing conditions than by deepening the cross-section near Houston street, artificially, on the west side. The effect produced by such an improvement would be more noticeable in the more uniform flow of the water than in the reduction of the velocities. This uniformity of flow would be still further encouraged by lowering Shell Reef to the plane of 18 feet below mean low water, and it is thought that the latter improvement is the more important of the two.

As the river advances westward from the Sound, the axis of the deep-water channel lies on the west or New York City side of Blackwell's Island, and follows that side closely till it reaches Thirty-third street, where it is deflected gradually to the opposite shore at Green Point. From this latter point it follows the Brooklyn side in a nearly direct course until Corlear's Hook is cleared. West of Wallabout Bay, within which the navy-yard is located, the water-way has, as far as the suspension bridge, a uniform width of 1,310 feet, and a cross-section of 55,000 feet, approximately. The maximum tidal velocity throughout the reach last considered has never been observed to exceed 3.5 nautical miles per hour.

From the foregoing it is estimated that while the reef on the west side of the river, east of Grand street, is an obstruction to the navigation of the river, by reason principally of the shoal depths over Shell Reef, the cross-section of the river at any point on the reef is in a very slight degree only diminished by the reef, so far as navigation is affected.

The most serious feature of the whole reef is the mass of hard material above the plane of 18 feet, mean low water, composing Shell Reef, which projects prominently into the deep-water channel opposite Tenth street. If this salient of the reef were removed down to 18 feet below mean low water, the main reef would lose many of its terrors, and the navigation of the channel near the wharves on the New York side would be greatly facilitated.

An inspection of the chart* shows that the natural channel is on the east bank, and it is the one which commerce will always follow when the weather is clear and the land-marks are visible. But in thick weather, when the shores are invisible, it is an easy matter for a vessel or steamer to lose her sailing course and to run into the dangerous shoal water formed by Shell Reef.

The history of the navigation of the river records the stranding of many vessels upon different parts of the reef.

The Sound steamer *Pilgrim* struck a rock of the reef opposite Nineteenth street in May, 1884, and received serious damage. The offending rock, known from that time as "Pilgrim Rock," was removed to a depth of 24 feet by the United States steam-drill scow in 1884. (Annual Report of the Chief of Engineers for 1885, page 733.)

Near the site of this rock, and closer in shore, there is another dangerous rock of small size, not previously mentioned, with only 16.7 feet depth of water over it at mean low water.

The following table gives the quantities of material to be removed, and the estimated cost, for deepening the shoal for giving navigable depths over the reef varying from 12 feet to 26 feet, viz:

Depth.	Cubic yards mud, sand, gravel, clay, and bowlders, at $1.	Cubic yards rock, at $30.	Estimated cost.
12 feet	5,779		$5,779
15 feet on Shell Reef	31,399		31,399
15 feet on entire shoal	36,348		36,348
18 feet	140,226	4,259	267,996
21 feet	334,392	23,185	1,029,942
24 feet	646,796	64,926	2,594,576
26 feet	923,828	103,963	4,042,718

No project which contemplates securing a less depth than 18 feet, mean low water, is worthy of consideration. The estimated cost for securing that depth is $267,996. To give an additional depth of 3 feet the estimate is increased to $1,029,942.

Commerce would be satisfied for many years to come, I think, with a full depth of 18 feet, mean low water, and the project for such an improvement is submitted with my recommendation, viz:

Removing 140,226 cubic yards mud, sand, gravel, clay, and bowlders, at $1 per cubic yard	$140,226
Removing 4,259 cubic yards rock, at $30 per cubic yard	127,770
	267,996

The points where improvement under this project would take place are located on the reef from Delancey street to Houston street, and from Eighth street to Seventeenth street.

East River is in the collection district of New York. The nearest fort is on Governor's Island and the nearest light-house is upon the eastern end of Blackwell's Island.

The amount of revenue collected at the port of New York for the year ending June 30, 1889, was $147,694,618.45.

The amount of commerce which will be benefited by the improvement considered in this report can not be accurately estimated, but it

* Omitted; printed in House Ex. Doc. No. 169, Fifty-first Congress, first session.

is certainly three-fourths of all which may be accredited to the port of New York.

I respectfully invite attention to the accompanying report of Mr. George W. Kuehnle, assistant engineer, under whose personal direction the survey was made.

Very respectfully, your obedient servant,

G. L. GILLESPIE,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. G. W. KUEHNLE, ASSISTANT ENGINEER.

ENGINEER OFFICE, U. S. ARMY,
New York, N. Y., January 15, 1890.

SIR: I have the honor to submit the following report on the survey of "the East River, with a view of the removal of a ledge of rocks in the same, from the foot of Broome street, to the foot of Twenty-third street, in New York City," made in compliance with the requirements of river and harbor act of August 11, 1888.

This shoal extends into the East River from the New York shore from Broome street to Twenty-third street, a distance of 8,300 feet, its maximum width being 1,100 feet (opposite Tenth street). The least depth on the most prominent portion of the shoal is 9 feet, mean low water, and this depth occurs opposite Tenth street and about 750 feet from the pier-head line.

The effect of the shoal is to reduce the available navigable channel for deep-draught vessels to 1,000 feet, and its crest being in the center of the channel makes it a constant menace to navigation, especially during foggy weather.

The survey was made by the hydrographic party in charge of Mr. J. Johnstone, beginning July 22, and completed September 27, 1889, with the exception of the borings, which were taken at intervals during October, November, and December, at such times as the services of the party were not needed elsewhere. A careful base line was measured and a system of triangulation carried across the river to determine accurately the necessary points for locating the soundings. The soundings were taken on ranges at right angles to the piers and about 100 feet apart, the distance between soundings on each range being approximately 50 feet; they were all taken with a graduated pole and each sounding was located by means of instruments on two triangulation stations.

On account of the strong currents, which a row-boat could not stem, it was not practicable to sound except during slackwater, and the progress of the survey was necessarily slow, as but from ninety to one hundred and fifty soundings could be taken per day, varying with the duration of the slackwater.

The piers on both sides of the river were accurately located by intersections from triangulation points.

The borings were taken by means of the "little scow" belonging to the Hell Gate plant. This scow, being moored by four anchors in the river, was placed in the desired position, a graduated pipe 2 inches in diameter was connected with the force pump by a rubber hose and lowered vertically until the end rested on the bottom, when a stream of water under a high pressure was forced through it, thus boring a way for the pipe, which was gradually lowered as the material was removed, until it was stopped by rock bowlders or material too hard for the jet to penetrate. In this way borings were made through 2 feet of clay, and while it was not possible to obtain samples of the material, the jet certainly defined the depth above which no bed-rock exists. The rapidity with which the pipe went down enabled the sounder to judge in a measure whether the material was soft or hard, and often it was possible to determine from the sound when the pipe was in gravel.

All borings and soundings were reduced to the plane of mean low water as established by the U. S. Coast Survey at Governor's Island, and transferred by simultaneous observations to Seventeenth street and East River, where a bench-mark was established in 1873. Detailed soundings were taken off Tenth Street and Seventeenth street to enable close computations to be made.

The soundings and notes were plotted on a scale of 1-2500 by the party in the field during the intervals between slackwaters and when the water prevented outside work. A reduction of the map, showing the curves and characteristic soundings, as well as a few of the borings, has been made.

The shoal, as developed by the borings, consists of mud, sand, and clay, through which are scattered large bowlders. There is no indication of solid rock, except opposite Ninth and Eleventh streets, and even there it is not certain that the jet was not stopped by bowlders rather than bed-rock. (In the computation this was assumed as bed-rock, and it is estimated accordingly.) From Thirteenth street to Twenty-third street the material seems to be more uniformly mud and sand, and there was no difficulty in forcing the jet down to 30 feet, mean low water. The material will be difficult to remove, owing to the swift currents and to the uncertainty as to when a bowlder will be found that will break the dipper or bucket.

The Dock Department of New York City dredged a 15-foot channel in front of the piers at Houston and Stanton streets, and had considerable trouble in finding a dredge capable of doing the work with a fair rate of progress.

The following is a table showing the quantities required to be removed to make the various depths over the shoal outside of the established pier-head line, and the estimated cost thereof:

Depth.	Cubic yards mud sand, gravel, clay, and bowlders, at $1.	Cubic yards rocks, at $30.	Estimated cost.
12 feet	5,779		$5,779
15 feet on shell reef	31,399		31,399
15 feet on entire shoal	36,348		36,348
18 feet	140,226	4,259	267,996
21 feet	334,392	23,185	1,029,942
24 feet	646,796	64,926	2,594,576
26 feet	923,828	103,963	4,042,718

No allowance has been included for increase in bulk or overdepth, as it is believed that after the work is started much of the material will be carried away by the swift currents.

Very respectfully, your obedient servant,

G. W. KUEHNLE,
Assistant Engineer.

Col. G. L. GILLESPIE,
Corps of Engineers, U. S. A.

E 13.

ESTABLISHMENT OF HARBOR LINES IN THE HUDSON RIVER FROM TROY TO COXSACKIE, NEW YORK.

ALBANY, N. Y., *September* 13, 1889.

DEAR SIR: We respectfully call your attention to the fact that the river channel at Colville's Follow, just below Troy, is becoming so contracted by the depositing of sand and other materials that it is almost impossible for two tows to pass each other without risk of doing damage. The Troy and Albany Iron and Steel Company are, to the greatest extent, causing this serious and dangerous obstruction to navigation by throwing in the waste and ashes from their furnaces, and the State authorities have been depositing sand in the same vicinity, which the tide has carried to the same place.

We urgently appeal to you for a remedy, and trust the matter will receive your immediate and proper attention.

Yours respectfully,

HARBOR No. 7, A. B. S. P.
JAMES H. DOLAN,
Clerk.

Hon. WILLIAM WINDOM,
Secretary of the Treasury.

[First indorsement.]

TREASURY DEPARTMENT,
BUREAU OF NAVIGATION,
September 18, 1889.

Respectfully referred to the Chief Clerk of the War Department.

F. B. SANDERS,
Acting Commissioner.

[Third indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
September 20, 1889.

Respectfully referred to Lieutenant Colonel G. L. Gillespie, Corps of Engineers, for report.

To be returned.

H. M. ADAMS,
Major, Corps of Engineers, In charge.

[Fourth indorsement.]

ENGINEER OFFICE, U. S. ARMY,
New York, October 26, 1889.

Respectfully returned to the Chief of Engineers, U. S. Army.

A separate report has been submitted to the Department this date.

G. L. GILLESPIE,
Lieut. Col. of Engineers.

[Fifth indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
October 30, 1889.

Respectfully returned to the Secretary of War.

The Albany Board State Pilots complain of contraction of Hudson River by deposits of sand, ashes, etc.

This paper was referred to Lieut. Col. G. L. Gillespie, Corps of Engineers, the officer in charge of the improvement of the Hudson River, whose report is herewith, to which attention is invited.

It is recommended that the Board on harbor-lines in New York harbor and adjacent waters, constituted by authority of the Secretary of War in January last, be directed to take into consideration and report on the establishment of harbor-lines in the Hudson River, beyond which no deposits shall be made, from Troy to Coxsackie, N. Y., in accordance with the provisions of section 12 of the river and harbor act of August 11, 1888.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Sixth indorsement.]

WAR DEPARTMENT,
November 1, 1889.

Approved as recommended by the Chief of Engineers.

By order of the Secretary of War.

JOHN TWEEDALE,
Chief Clerk.

[Seventh indorsement.]

OFFICE CHIEF OF ENGINEERS.
U. S. ARMY.
November 2, 1889.

Respectfully referred to Col. H. L. Abbot, Corps of Engineers, and his attention invited to the fifth and sixth indorsements.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Eighth indorsement.]

NEW YORK HARBOR-LINE BOARD,
ARMY BUILDING,
New York City, December 18, 1889.

Respectfully referred to Lieut. Col. G. L. Gillespie, Corps of Engineers, with request that he furnish this Board with his views as to the harbor-lines necessary for the locality indicated in these papers.

For the Board.

HENRY L. ABBOT,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
President of the Board.

[Ninth indorsement.]

ENGINEER OFFICE, U. S. ARMY,
New York, February 18, 1890.

Respectfully returned to Col. H. L. Abbot, president of the New York Harbor-Line Board.

The lines "necessary for the locality indicated in these papers," in my judgment, should follow closely the outer faces of the works of improvement constructed by the United States for defining and maintaining the navigable channels of the Hudson River from Troy to New Baltimore. The lines, delineated upon five sheets of the latest survey of the river, will be laid before the Board for its consideration at the meeting appointed for to-day.

G. L. GILLESPIE,
Lieut. Col. of Engineers.

[Tenth indorsement.]

NEW YORK HARBOR-LINE BOARD,
New York City, March 21, 1890.

Respectfully returned inviting attention to the report of the New York Harbor-Line Board to the Chief of Engineers, dated March 18, 1890, recommending harbor-lines for the Hudson River from the State dam at Troy to New Baltimore, N. Y.

HENRY L. ABBOT,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
President of the Board.

REPORT OF LIEUTENANT-COLONEL G. L. GILLESPIE, CORPS OF ENGINEERS.

ENGINEER OFFICE, U. S. ARMY,
New York, October 26, 1889.

GENERAL: I have the honor to send, herewith inclosed, copy of a report by Mr. Charles G. Weir, assistant engineer, on the subject of ob-

structions to the navigation of the Hudson River in the vicinity of Troy, N. Y., by the Troy and Albany Iron and Steel Company, which I was directed to report upon by third indorsement, Office Chief of Engineers, September 20, 1889, on letter addressed to the Secretary of the Treasury by Albany Board State Pilots, under date September 13, 1889.

The encroachments from the left bank upon the channel of the river, opposite Breaker's Island, have been in progress for many years, but I have not been able to find that any river-lines for restraining encroachments were ever adopted by the State. The office maps show a certain pier-line which it is said was located by Mr. Talcott, assistant engineer, to comply with the requirements of a Harbor-Line Board formed in 1877, and of which General Newton was a member. I can not find upon the files any authority for the organization of said Board, and General Newton does not remember to have been a member of such a Board, nor to have made a report. It is probable that it was the Board composed of Chief of Engineers, Superintendent Coast Survey, and Lieutenant-Colonel Newton, Corps of Engineers, convened by Special Order 101, War Department, Adjutant-General's Office, April 30, 1872, for examination and report upon the harbor-lines for Long Island and Staten Island, New York Harbor, and which was not discontinued until 1878 or 1879, and that General Newton, as one of the members, asked the Board to consider the river-lines at Troy, New York.

The office records contain reports of the Board on New York Harbor Lines, but none on Hudson River.

Mr. R. H. Talcott, assistant engineer, in a report to Lieutenant-Colonel McFarland, dated June 18, 1885, invites attention to the encroachments now complained of at Troy, N. Y., and states that the dump was then 50 feet outside the limit of the grant of land under water to Mr. Erastus Corning, at that point (Annual Report, Chief of Engineers, 1885, page 696).

The riparian owners along the left bank opposite Breaker's Island should be prohibited from encroaching any more upon channel-way by the deposit of light material upon the banks, and should be required to build substantial and permanent bulkheads to hold and retain the material already dumped there. The lines for the bulkheads should be established by this office or by the Harbor-Line Board for New York Harbor, constituted by Special Orders 47, Headquarters Corps of Engineers, October 5, 1888, to comply with section 12, river and harbor act, August 11, 1888.

In fact, the navigable waters of the upper Hudson River from New Baltimore to Troy, N. Y., are being so materially threatened by ill-advised deposits of material dredged from various bars in the river, under the authority of the State, that it is highly important and necessary that the United States should intervene and establish dock lines, beyond which no deposits shall be made, all the way from Troy to Coxsackie, N. Y.

Very respectfully, your obedient servant,

G. L. GILLESPIE,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. CHARLES G. WEIR, ASSISTANT ENGINEER.

NEW YORK CITY,
October 26, 1889.

COLONEL: I have the honor to submit the following report on the contraction of the channel of the Hudson River, at Coville's Folly, below the Bessemer Steel Works near Troy, N. Y.

In accordance with your letter of instruction dated September 21, 1889, I have made an examination of the ground covered by the complaint of the Albany pilots to the honorable the Secretary of the Treasury, and beg leave to hand you herewith a tracing with present channel and shore lines, as also the channel of 1877 and shore lines of 1877 and 1884, showing the encroachments. For a distance of 3,000 feet along the east bank of the Hudson, the Troy Iron and Steel Company have been dumping the refuse material (slag and cinders) from their furnaces for the past thirteen years and have narrowed up the river along this distance from 50 to 150 feet. There being quite a deflection in the course of the river at this point, the current and ice in the spring freshets cut into and carry away great quantities of this material, which finds its way into the channel below, no retaining wall or bulkhead ever having been built to confine it. In 1877 a bulkhead line was projected by a special board and a line located by the assistant engineers making the bulkhead line at this place. These lines do not quite agree, as shown on the tracing by the red and blue lines. Material, however, has been filled in, in places 20 feet beyond the bulkhead as laid out. I have learned also that in 1887 the State dumped most of the material removed from the Washington bar along the east shore between the Bessemer Dock and the north end of the steel company's dump. There is very little evidence, however, of any change in the immediate channel since 1877 as shown by the tracing, the least width of channel at present being 270 feet between the 6-foot curves and 100 feet between the 9-foot curves. In conclusion, however, great quantities of the material of the steel company's dump are being continually washed away and deposited in the channel somewhere below the limits of contraction by encroachment, and the company should be compelled to build a bulkhead or retaining wall to confine the material already deposited by them.

Respectfully submitted.

CHARLES G. WEIR,
Assistant Engineer.

Lieut. Col. G. L. GILLESPIE,
Corps of Engineers, U. S A.

HARBOR-LINES IN HUDSON RIVER FROM TROY TO NEW BALTIMORE, NEW YORK.

HARBOR-LINE BOARD,
New York City, March 18, 1890.

GENERAL: The Harbor-Line Board for New York Harbor and its adjacent waters, constituted by Special Orders No. 49, Headquarters Corps of Engineers, October 5, 1888, to comply with section 12 of the river and harbor act of August 11, 1888, has the honor to recommend for the approval of the Secretary of War certain harbor-lines, delineated upon five sheets, showing the river from State Dam at Troy, N. Y., to New Baltimore, N. Y., "beyond which no piers or wharves shall be extended or deposits made, except under such regulations as may be prescribed from time to time by him (Secretary of War)."

This duty was confided to the Board by instructions from the Secretary of War contained in indorsement 6, dated November 1, 1889, upon a communication addressed September 13, 1889, by the Albany State Board of Pilots to the Secretary of the Treasury, referring to certain alleged obstructions to the Hudson River between Troy, N. Y., and Albany, N. Y., caused by illegal dumpings made by the Troy and Albany Iron and Steel Company and others at, or in the vicinity of, Colville's Bar, Breaker's Island.

In recommending these lines the Board has adopted the principle that they should follow closely the outer or channel faces of the works

of improvement constructed by the United States for defining and maintaining the navigable channels improved, or projected for improvement, between Troy, N. Y., and New Baltimore, N. Y.

The Government works are longitudinal dikes of stone and timber, used singly or combined, and form either revetments for the natural shore line or artificial banks for the river wherever the natural direction of the channels has been changed.

The width of the improved channel embraced between the dikes is 500 feet at Troy, 800 feet at Albany, and 1,200 feet at New Baltimore. The depth at mean low water is 9 to 10 feet, approximately.

The river throughout the reach considered is filled with islands which caused originally a division of the stream into numerous shoal waterways, none of which afforded to Troy a navigable depth exceeding 6 feet, mean low water.

The dikes which give direction to, and form the banks of, the improved channels are at a few points located at a distance of 3,500 feet from the adjacent natural shore, but the average distance does not exceed 1,500 feet.

Heretofore the river-bed has been improperly used as a dumping-ground for material dredged from the bars. The State laws in this regard are sufficient to prevent illegal dumpings in the channels, but for reasons unknown to the Board they have not been enforced. In future all material taken from the river should be placed behind the recommended lines, protected from the currents of the river by existing dikes or by dikes which may be built to give such protection where no dikes now exist.

The lines which are recommended in this report for the approval of the Secretary of War are laid out, where possible, by offsets from the base lines established and used by the New York State Survey of 1887, and are described in detail in a separate paper which, with five illustrative sheets, forms an inclosure to this report.

Very respectfully, your obedient servants,

HENRY L. ABBOT,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.
WM. P. CRAIGHILL,
Colonel of Engineers.
C. B. COMSTOCK,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.
G. L. GILLESPIE,
Lieutenant-Colonel of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
March 22, 1890.

Respectfully submitted to the Secretary of War.

The Harbor-Line Board for New York Harbor and its adjacent waters, constituted by Special Orders No. 49, Headquarters Corps of Engineers, October 5, 1888, recommends for the approval of the Secretary of War certain harbor-lines in the Hudson River between Troy and New Balti-

more, described in accompanying paper and delineated upon inclosed (five) tracings.

It is recommended that the lines selected be approved, and that the Secretary place his approval upon the report and upon each of the tracings submitted.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Second indorsement.]

WAR DEPARTMENT,
March 25, 1890.

Approved.

REDFIELD PROCTOR,
Secretary of War.

DESCRIPTION OF THE HARBOR-LINES FOR THE HUDSON RIVER FROM THE STATE DAM AT TROY, NEW YORK, TO NEW BALTIMORE, NEW YORK, ADOPTED BY THE HARBOR-LINE BOARD FOR NEW YORK HARBOR AT ITS SESSION HELD IN THE CITY OF NEW YORK FEBRUARY 18, 1890, AND SUBMITTED TO THE SECRETARY OF WAR FOR APPROVAL MARCH 18, 1890.

The lines are laid out upon United States Engineer maps of the river prepared from the surveys of 1884, extending from Troy to New Baltimore, N. Y., and all the measurements given in the following description are scaled from the maps.

1. East Bank from Troy to New Baltimore.
2. West Bank from Troy to New Baltimore.

1. EAST BANK, TROY TO NEW BALTIMORE.

Beginning at a point on the east side of the Hudson River where the present dock line intersects the south face of the wall of the sloop-lock at the State Dam; thence on a straight line southerly 145 feet along the present dock line to a point where the center line of Middleburg street produced intersects the present dock line, which line is distant from the west line of River street (which is the west side of the basin) 170 feet, measured on the center line of Middleburg street; thence in a straight line southerly 1,405 feet to a point on the shore, which referred to a point at the northwest corner of Jay and River streets, is 187 feet westerly along the north building line of Jay street and 68 feet northerly on a line parallel to the west side of River street; thence 508 feet a straight line southerly to a point on the center line of Van der Heyden street, 125 feet west of the building line of River street; thence in a straight line southerly 150 feet to a point on the present dock line 117 feet distant from the west building line of River street, measured perpendicular thereto; thence in a straight line southerly 240 feet to a point where the north building line of Hoosick street intersects the present dock line, being 138 feet from the west building line of River street, and thence in a straight line southerly on the same line produced 560 feet to a point on the present dock line; thence 130 feet along the present dock line to the intersection of the center line of Hutton street and the present dock line, which point is 95 feet distant from the west line of River street, measured along said center line of Hutton street; thence by a curve to the right, whose radius is 1,980 feet, a distance of 1,255 feet, measured by chords of 100 feet to a point on the center line of Federal street, just south of the Delaware and Hudson Railroad and where that center line intersects the present dock line 252 feet from the west line of River street; thence southwesterly by a straight line for a distance of 365 feet to a point on the center line of Grand street, where said line intersects the present dock line 102 feet, from the west line of Front street, south of Grand street; thence southwesterly on a straight line for a distance of 1,028 feet, to where the center line of Broadway intersects the present dock line, being distant from the west line of River street 222 feet along the center line of said Broadway; thence by a straight line southwesterly a distance of 400 feet to a point in the present dock line 57 feet from the west line of Front street, on a line perpendicular thereto; thence southwesterly 200 feet along the present dock line, and thence along the present dock line 173 feet, to where the center line of State street intersects the present dock line, 280 feet from the west line of River street; thence on the same line continued along the present dock line, 210 feet; thence along the present dock line 190 feet; thence 530

feet to the corner of the ferry slip at the foot of Ferry street, which point is 250 feet west of the west line of River street; thence by a straight line 1,210 feet to a point on the center line of Washington street produced, 166 feet from the west line of Front street; thence by a straight line 320 feet to a point in the present dock line, which is 185 feet west of the west line of Front street on a line perpendicular thereto; thence by a straight line 1,288 feet to the corner of the present dock line on the north side of Poesten Kill, and 423 feet from the west line of River street on a line perpendicular thereto; thence by a straight line 1,153 feet to the intersection of the center line of Monroe street with the present dock line, 473 feet from the west building line of River street; thence by a straight line 2,590 feet to a point on the present dock line of Burden's Dock, which is 900 feet distant from the center line of the Albany and Greenbush Railroad and perpendicular thereto; thence along the present dock line 410 feet; thence along the present dock line 450 feet to angle in the present dock line; thence along the present dock line 470 feet to angle in the present dock line; thence along the present dock line 912 feet to the corner of the dock of Troy Steel and Iron Company, on the south side of Winant's Kill; thence along the present dock line 1,430 feet to the corner of dock on the line dividing the property of the Troy Steel and Iron Company from that of James Burden, and distant on said line from the center line of the Albany and Greenbush Railroad 305 feet; thence by a curve to the right, whose radius is 2,230 feet, a distance of 1,265 feet, measured in chords of 100 feet to a point distant 62 feet from the center line of the Albany and Greenbush Railroad, measured on the radius of the curve produced; thence by a straight line 4,303 feet to a point on the west face of Base Island Crib Dike, which is 200 feet from the north end of said dike and 210 feet from S. S. Station "Railway" 231, measured westerly on a line perpendicular to Base Island Dike and along the face of said dike 173 feet northerly; thence along the channel face of said dike which, referred to a base line through S. S. Station "Railway" 231, as origin and "Forbes" 191, is described by the following co-ordinates:

Abscissæ.	Ordinates.
Feet.	*Feet.*
1,532	+530
2,602	+763
3,943	+930
4,600	+995
6,400	+1,110
6,996 (S.S. "Forbes" 191)	+1,160

Thence referred to a base line through S. S. Station "Forbes" 191, as origin and "Bath" 190, is described by the following co-ordinates:

Abscissæ.	Ordinates.
Feet.	*Feet.*
1,275	+835
2,236	+635
2,725	+550
3,283	+490
3,934	+450

Thence referred to a base line through S. S. Station "Bath" 190 as origin and "Ball Grounds" 230 is described by the following co-ordinates:

Abscissæ.	Ordinates.	
Feet.	*Feet.*	
213	+515	North corner of Bath Dock.
1,398	+648	South corner of Bath Ferry Slip.
3,210	+812	Point on New York Central Railroad Bridge.
4,653	+650	Corner of Dock.
5,150	+563	Do.
6,138	+295	Do.

Thence referred to a base line through S. S. Station "Ball Grounds" 230 as origin and "Moles" 156 is described by the following co-ordinates:

Abscissæ.	Ordinates.	
Feet.	*Feet.*	
1,140	+248	Corner of dock.
1,553	+365	Do.
2,742	+535	Do.
3,332	+472	Corner of State dike.
4,868	+360	Along face of State dike.

Thence referred to a base line through S. S. Station "Moles" 156 as origin and "Denison" 166 is described by the following co-ordinates:

Abscissæ.	Ordinates.	
Feet.	*Feet.*	
642	+273	Along dike.
882	+295	
2,038	+575	
4,169	+685	North end, Sec. I, Papscannee Dike.

Thence referred to a base line through S. S. Station "Denison" 166 as origin and "Papscannee" 158 is described by the following co-ordinates:

Abscissæ.	Ordinates.	
Feet.	*Feet.*	
466	+ 970	Along dike.
2,053	+1,020	
2,695	995	South end Sec. I, Papscannee Dike.
3,258	960	
4,118	912	
4,972	697	At the south corner channel face of Papscannee Dike, Section II.

Thence referred to a base line through S. S. Station "Papscannee" 158 as origin and "Cooper" 164 is described by the following co-ordinates:

Abscissæ.	Ordinates
Feet.	*Feet.*
521	+458
3,135	+660

Which point is at the corner of Papscannee Dike, section III., on the channel face, and which is a point of curve to the left whose radius is 2,350 feet and length 1,300 feet to a point of reversed curve whose co-ordinates are:

Abscissa.	Ordinate.
Feet.	*Feet.*
4,383	+345

Thence along a line of curve to the right for a distance of 2,030 feet, and whose radius is 3,900 feet to a point of compound curve which, referred to a base line through

S. S. Station "Cooper" 164 as origin and "Muller" 159, is described by the following co-ordinates:

Abscissa.	Ordinate.	
Feet. 1,710	*Feet.* —315	Point of compound curve.

Thence by a curve to the right whose radius is 7,500 feet for a distance of 2,915 feet to a point of compound curve the co-ordinates of which are—

Abscissa.	Ordinate.
Feet. 4,613	*Feet.* —78

Thence by a curve to the right whose radius is 1,625 feet for a distance of 510 feet to a point of reversed curve whose co-ordinates are—

Abscissa.	Ordinate.
Feet. 5,085	*Feet.* +120

Thence by a curve to the left whose radius is 1,250 feet and its length 410 feet to a point of tangent whose co-ordinates are—

Abscissa.	Ordinate.
Feet. 5,470	*Feet.* +282

Thence referred to a base line through S. S. station "Muller," 159, as origin and "Campbell Island," 163, is described by the following co-ordinates:

Abscissa.	Ordinate.	
Feet. 378	*Feet.* +242	North corner of Staats' Dock.

Which is a point of curve; thence along a curve to the right whose radius is 5,000 feet for a distance of 1,615 feet to a point of tangent on the channel face of angle in Staats' Single Pile Dike, the co-ordinates of which are—

Abscissa.	Ordinate.
Feet. 1,980	*Feet.* +75

Thence referred to the same base line, is described by the following co-ordinates:

Abscissæ.	Ordinates.
Feet.	*Feet.*
3,114	+160
5,032	+340
5,920 (S. S. station Campbell Island, 163.)	+451

To a point which referred to a base line through S. S. station "Campbell," 163, as origin and "Castleton," 167, is described by the following co-ordinates:

Abscissa.	Ordinate.
Feet.	*Feet.*
40	+450

Thence southerly and along the channel-face of the single-pile dike referred as above, and described by the following co-ordinates:

Abscissæ.	Ordinates.
Feet.	*Feet.*
878	+512
2,248	+645

The north end of the channel-face of Campbell Island Dike; thence along said dike referred as above and described by the following co-ordinates:

Abscissæ.	Ordinates.	
Feet.	*Feet.*	
2,998	+700	
3,122	+700	
3,280	+699	
3,472	+675	Corner of dock.
3,942	+618	

Which is at an angle of Campbell Island Dike; thence by a straight line a distance of 285 feet to a point of curve described by the following co-ordinates:

Abscissa.	Ordinate.
Feet.	*Feet.*
4,227	+579

Thence by a curve to the right, whose radius is 4,166.6 feet and length 615 feet, to a point of tangent on the channel-face of Cow Island Dike and described by the following co-ordinates:

Abscissa.	Ordinate.
Feet.	*Feet.*
4,815	+538

Thence along the face of said dike to a point whose co-ordinates are described as follows:

Abscissæ.	Ordinates.
Feet.	*Feet.*
5,158	+540
5,846	+543
6,096	+552

Thence along Cow Island Single Pile Dike to its southern end and on the channel-face, which point referred to a base line through S. S. station "Castleton," 167, as origin, and "Clapper," 161, is described by the following co-ordinates:

Abscissa.	Ordinate.
Feet. 680	*Feet.* +568

Thence on a straight line as described by the following co-ordinates:

Abscissa.	Ordinate.
Feet. 4,153	*Feet.* +469

To a point on the channel-face of Castleton Dike where the north face of the branch dike intersects the channel-face of the main dike; thence along said dike to a point described by the following co-ordinates:

Abscissa.	Ordinate.
Feet. 5,002	*Feet.* +585

Thence along said dike as described by the following co-ordinates:

Abscissa.	Ordinate.
Feet. 6,021	*Feet.* 650

Thence along the channel-face of State Dike as described by the following co-ordinates:

Abscissa.	Ordinate.
Feet. 7,486	*Feet.* +1,022

Which point referred to a base line through S. S. station "Clapper," 161, as origin, and "Mull's Plaat," 173, is described by the following co-ordinates:

Abscissa.	Ordinate.
Feet. 205	*Feet.* +1,002

Thence, as referred above, along the channel-face of State Dike and described by the following co-ordinates:

Abscissa.	Ordinates.
Feet. 1,680	*Feet.* +1,008
2,348	+ 985

To south end of the channel-face of State Dike at Nine Mile Tree; thence as referred above and described by the following co-ordinates:

Abscissæ.	Ordinates.	
Feet.	*Feet.*	
4,003	+902	North end of United States Dike.
4,805	+870	
5,573	+775	
6,778	+630	
7,956	+502	
8,360	+465	To south end of full dike below.
8,830 Mull's Light.	+420	South end of half dike.
10,950	+208	
11,812 Which point is S. S. station 173.	+ 32	

Thence referred to a base line through S. S. station "Mull's Plaat" 173, as origin, and "Lower Schodack Island," 180, is described by the following co-ordinates:

Abscissæ.	Ordinates.	
Feet.	*Feet.*	
183	+ 150	
1,886	+ 582	North end of State Dike,
4,130	+1,154	
4,458	+1,215	South end of State Dike.
5,056	+1,412	

Which is a point of curve to the left whose radius is 1,470 feet and length 1,420 feet; thence along said curve to a point of tangent whose co-ordinates are described as follows:

Abscissæ.	Ordinates.
Feet.	*Feet.*
6,485	+1,378
6,658	+1,314

Which is a point of curve to the right whose radius is 880 feet and length 242 feet, to a point of tangent whose co-ordinates are described as follows:

Abscissæ.	Ordinates.
Feet.	*Feet.*
7,003	+1,270
8,276	+1,328
8,545	+1,390
9,268	+1,545
9,658 Which point is S. S. station "Lower Schodack Island," 180.	+1,622

Thence referred to a base line through S. S. station Lower Schodack Island 180, as origin, and Hotailing Island 279 is described as follows:

Abscissæ.	Ordinates.	
Feet.	*Feet.*	
628	+1,517	Same point as above, 7,658 feet + 1,622 feet.
1,194	+1,325	
1,898	+1,107	
3,550	+ 538	
3,558	+ 518	
4,020	+ 357	
4,963 Which point is S. S. station "Hotailing Island," 179.	+ 40	

referred to a base line through S. S. station, "Hotailing Island," 179, as origin, Van Alstyne," 244, is described by the following co-ordinates:

Abscissæ.	Ordinates.
Feet.	*Feet.*
393	+ 460
1,512	+1,015
3,612	+1,510

2. WEST BANK, TROY TO NEW BALTIMORE.

nning at a point on the present dock at the State Dam on the west side of the n River at Troy, N. Y., 175 feet east of the east building line of Hudson avenue ed and 163 feet north of the north building line of Bleecker street produced; southerly 445 feet to a point 242 feet from east line of Hudson avenue; thence raight line southerly 1,112 feet to a point on the center line of Center street ed and 218 feet easterly on said line from the east line of Hudson avenue; southerly on the same line 258 feet; thence 1,190 feet to a point on the center Hamilton street produced and 412 feet from the west line of George street; by a straight line 938 feet to a point on the present dock line at the intersec- the south line of Washington street; thence along the present dock line 985 a point on the center line of Saratoga street distant 165 feet from the east Hudson avenue; thence by a straight line 917 feet along the present dock to r which is 87 feet east of the east line of Hudson avenue; thence following sent dock line to a point which is 360 feet northerly from north side of Congress Bridge along said dock line, and thence by a straight line 1,050 feet to the cor- dock on west side of ferry slip at the foot of Sixteenth street, 382 feet from east Broadway on a line parallel to the line of Sixteenth street; thence by a t line 1,200 feet to a point on the present dock line 192 feet east of the east line dway and 158 feet north of north line of Fourteenth street produced; thence traight line along the present dock line 148 feet to a point on the present dock 2 feet east of the east line of Broadway at Fourteenth street and 12 feet north line; thence by a straight line 1,110 feet to a point at the north corner of sent stone dock at the arsenal, where it intersects the south wall of water- hence by a straight line 762 feet along the Arsenal Dock to the southeast of said dock; thence 1,290 feet to a point on the present dock line near Ninth which is 55 feet north of north line of Ninth street and 250 feet east of east Broadway; thence by a straight line 910 feet to a point on the south line of h street and 285 feet east of the east line of Broadway; thence on the continu- f said line 220 feet to a point of curve which is 298 feet east of the east line adway measured on a line parallel to Seventh street; thence by a curve to t whose radius is 5,833.3 feet 320 feet to a point on the curve and at the inter- of the center line of Sixth street produced 320 feet east of the east line of way; thence on the same curve 470 feet to a point on the line of the north Roy's shawl factory produced, and 195 feet east of the northeast corner of ctory; thence by the same curve 816 feet to a point on the projection of the building line of Roy's shawl factory produced, and 390 feet from the southeast of said factory; thence on the same curve 815 feet to a point of tangent at the ter line on the channel-face of Port Schuyler Dike, which point is 942 feet east west line of Broadway and on a line parallel to the center line of First street feet north of the south line, making a total length of 2,421 feet; thence said dike at low-water line on the channel-face a distance of 1,745 feet to a f curve, and thence by a curve to the right whose radius is 2,180 feet a dis- of 1,450 feet to a point of tangent, and thence by a straight line southwest- 790 feet to the north end of Hillhouse Island Revetment at low-water line; along said face of revetment 838 feet, and thence by a straight line 1,075 feet int at the south end of said revetment at low-water line; thence by a straight ong the channel-face of High Dike 753 feet to a point on said channel-face, point is distant 435 feet from S. S. station "Race Course," 236, on line perpen- r to the line of said dike; thence along said dike 2,193 feet to a point at the ex- south end of High Dike, and thence by a straight line along the face of Pa- Island Dike at mean low-water line for a distance of 1,470 feet to a point which endicularly distant from S. S. station 192, 693 feet, and thence on the same line ed 100 feet to a point where the present dock line intersects Patroons Island t low-water line and thence by a straight line along the channel-face of said r a distance of 725 feet to about the end of Patroons Island Revetment, which

point, referred to a base line through S. S. station 192 as the origin and "Sage," 189, is described as follows by co-ordinates:

Abscissæ.	Ordinates.	
Feet.	*Feet.*	
763	— 803	End of Patroons Island Revetment.
2,500	—1,102	
2,988	—1,155	
4,193	—1,230	
4,800	—1,270	
5,435	—1,270	

Thence referred to a line passing through S. S. station "Sage" 189, as origin and "Abutment," 188, described by the following co-ordinates:

Abscissæ.	Ordinates.	
Feet.	*Feet.*	
362	—1,226	
838	—1,145	
1,698	— 900	South corner of dock.
2,835	— 532	

Which point is about 150 feet south of the extreme south end of Patroons Lower Island.

The bulkhead line on the west shore of Patroons Lower Island, referred to a base line through S. S. station 192 as origin and "Sage," 189, is described by the following co-ordinates:

Abscissæ.	Ordinates.
Feet.	*Feet.*
2,862	—450
5,187	—352

And referred to a base line through S. S. station "Sage," 189, as origin and "Abutment," 188, is described by the following co-ordinates:

Abscissæ.	Ordinates.
Feet.	*Feet.*
1,685	—263
2,760	—420

The bulkhead line along the main west shore at the lumber district at Albany, referred to a base line through S. S. station 192 as origin and "Sage," 189, is described by the following co-ordinates:

Abscissæ.	Ordinates.
Feet.	*Feet.*
4,037	—152
4,377	—120
5,332	—108

And referred to a base line through S. S. station "Sage," 189, as origin and "Abutment," 188, is described as follows:

Abscissæ.	Ordinates.	
Feet.	*Feet.*	
485	.....	
1,264	+100	
2,561	—120	
2,605	—187	
2,785	— 95	At north corner of ferry slip.
3,881	— 78	At south corner of ferry slip.
4,487	— 37	At northeast corner Columbia Street Pier, Albany Basin.
5,122	—49	

To a point on the channel face of Columbia Street Pier; thence along the present dock line 1,235 feet; thence 788 feet, to the southeast corner of said pier; thence, beginning at the northeast corner, on the channel face of the State Street Pier and present dock line, and running along said line 1,000 feet, to the southeast corner; thence, beginning at a point on the present dock line where the south line of Hamilton street intersects the present dock line and 198 feet from the west line of Broadway; thence 610 feet to a point on the present dock line which is 296 feet north of the south line of Madison avenue and 178 feet east of the east line of Broadway projected, and thence running along said dock line 298 feet, to a point where the present dock line intersects the south line of Madison avenue and 220 feet from the east line of Broadway; thence by a straight line, following the present dock line, 945 feet, to where the present dock line is intersected by the projection of the north building line of Ferry street, the approach to the bridge, and 245 feet from the east line of Broadway; thence along the present dock line 520 feet, to where the center line of Rensselaer street intersects the present dock line, and 231 feet east of the east line of Broadway; thence along the present dock line 525 feet to where the center line of Cherry street intersects the present dock line, and distant 218 feet from the east line of Broadway; thence along the present dock line 565 feet, to where the south line of Fourth avenue, produced, intersects the present dock line, and distant from the east line of Broadway 215 feet; thence from said point, on a straight line, 2,208 feet to a point at the angle on the channel-face of Small Island Dike, 700 feet from the southeast corner of Jagger Furnace Dock; thence along the channel-face of said dike 800 feet; thence 685 feet, 460 feet, 835 feet, 1,085 feet, and 740 feet, to the end of said dike, where it intersects the half dike at the north end of Bogart Island, which point referred to a base line through S. S. station "Westerloe Island," 170, as origin and Parke bolt, is described as follows:

Abscissa.	Ordinate.	
Feet.	*Feet.*	
830	—620	North end of Bogart Island Dock.

Thence along the channel-face of Bogart Island Dike, referred to the same base line, is described by the following co-ordinates:

Abscissæ.	Ordinates.
Feet.	*Feet.*
1,192	—670
2,446	—502
3,685	—373

Which is a point on the channel-face at the north end of Overslaugh Dike No. 1 at low-water line; thence along the channel-face of said dike at low-water line as described by following co-ordinates:

Abscissæ.	Ordinates.
Feet.	*Feet.*
4,968	—550
5,390	—612
5,834	—690
6,900	—872
7,118	—935

To a point at the end of Overslaugh Dike No. 1; thence along the channel-face of single pile-dike as described by the following co-ordinates:

Abscissæ	Ordinates.
Feet.	*Feet.*
7,295	— 990
7,945	—1,240

Which is a point in the channel-face at the angle in Abbey Channel Dike; thence along the channel-face of said dike and Overslaugh Dike No. 2 at low-water line referred to a base line through S. S. station Parke, bolt as origin and "Van Wie," 146, as described by the following co-ordinates:

Abscissæ.	Ordinates.	
Feet.	*Feet.*	
1,068	—1,053	North end of Overslaugh No. 2 at M. L. W. L.
1,960	— 870	
3,638	— 380	
4,478	— 173	
5,142	— 50	

Which point is on the channel-face at the lower end at low-water line of Overslaugh Dike No. 2, thence

Abscissa.	Ordinate.
Feet.	*Feet.*
6,092	—20

Which point is the south end of Stone Light Dike at Stone Light.

The bulkhead line along the main shore referred to the same base line is described as follows:

Abscissa.	Ordinate.
Feet.	*Feet.*
5,550	+324

Thence referred to a base line through S. S. station "Van Wie," 146, as origin and "Winnie's Dock," 160, is described by the following co-ordinates:

Abscissæ.	Ordinates.	
Feet.	*Feet.*	
00	— 68	
755	—300	Northeast corner of Winnie's Dock.
878	—300	Southeast corner of Winnie's Dock.
1,612	—380	Northeast corner of a dock.
1,747	—387	Southeast corner of same dock.
4,369	—125	To an angle in the channel-face of Winnie's Single Pile Dock.

Thence along the channel-face of said dike—

Abscissa.	Ordinate.	
Feet.	*Feet.*	
6,170	—35	To the corner of a dock.

Thence referred to a base line through S. S. station "Winnie's Dock," 160, as origin and "Parda Hook," bolt, is described by the following co-ordinates:

Abscissæ.	Ordinates.	
Feet.	*Feet.*	
128	—30	
1,310	+68	
2,052	+60	
2,923	—60	Which point is on the channel-face of the dike at Parda Hook Light.
3,680 (Parda Hook, bolt.)	—79	Beginning of bulkhead line at Parda Hook.

Thence referred to a base-line through S. S. Station "Parda Hook," bolt as origin and "Baker" 162, is described by the following co-ordinates:

Abscissæ.	Ordinates.	
Feet.	*Feet.*	
700	— 157	At the corner of a dock.
1,035	— 132	
1,802	— 220	South end of Cedar Hill Single Pile Dike.
4,382	— 578	Angle in the channel face of Cedar Hill Dike.
4,834	— 656	Along the channel face of Cedar Hill Dike.
6,642	—1,018	Do.
7,523	—1,035	Do.
8,087	—1,057	Do.
8,362	—1,055	Do.

which point is a point of curve; thence leaving the channel face of the dike by a curve to the left, whose radius is 4,166.6 feet and length 600 feet, to a point of reversed curve, which point is described by the following co-ordinate:

Abscissæ.	Ordinates.
Feet.	*Feet.*
8,954	—1,105

Thence by a curve to the right, whose radius is 9,166.6 feet, for a a distance of 4,625 feet, and further described by the following co-ordinates referred to a base line through S. S. Station "Baker" 162 as origin and "Shad Island" 171:

Abscissæ.	Ordinates.	
Feet.	*Feet.*	
138	—1,190	Corner of Ridgewood's Ice Company's Dock.
1,147	—1,228	
2,055	—1,170	Corner of an ice company's dock.
2,403	—1,123	Corner of a dock.
4,032	— 715	

which point is the end of the curve. The bulk-head line along the main shore west of Schermerhorn Island, referred to a base-line through S. S. Station "Baker" 162 as origin and "Shad Island" 171, is described by the following co-ordinates:

Abscissæ.	Ordinates.
Feet.	*Feet.*
748	—108
5,189	—278

which point is the end of Shad Island Dike north; thence referred to a base line through S. S. Station "Shad Island" 171 as origin and "Mulls" 169, is described by the following co-ordinates:

Abscissæ.	Ordinates.	
Feet.	*Feet.*	
765	—187	South end of Shad Island Dike.
1,513	—195	Channel face of dike at Mull's Upper Beacon.
2,186	—210	
4,110	—358	Channel face of dike at Mull's Upper Beacon.
6,767 (S. S. Sta. Mull's 169).	—538	

Thence referred to a baseline through S. S. Station "Mull's" 169 as origin and "Roach Hook" 174, is described by the following co-ordinates:

Abscissæ.	Ordinates.	
Feet.	*Feet.*	
1,172	—400	Northeast corner of dock at North Coeyman's ice-house.
1,420	—388	Southeast corner of dock at North Coeyman's ice-house.
2,547	—258	
3,600	—220	
4,962	—365	

which is a point on the channel face at the north end of Roach Hook half dike; thence referred to a baseline through S. S. Station "Roach Hook" 174 as origin and "Van Dalfsen" 177, is described by the following co-ordinates:

Abscissæ.	Ordinates.	
Feet.	*Feet.*	
720	— 372	
1,320	— 435	
1,626	— 482	End of channel face of Roah Hook Dike.
1,710	— 450	North end on channel face of Coeyman's Dike.
2,050	— 280	
2,298	— 210	
2,698	— 172	
2,959	— 188	
3,603	— 300	Corner of Brigg's Dock at Coeyman's.
4,270	— 433	
4,807	— 702	
4,875	— 752	
5,063	— 872	
5,318	—1,070	
5,578	—1,360	South end of channel face of Barren Island Dike.
6,077	—1,655	Dock line at Barren Island.
6,238	—1,692	
6,450	—1,710	Corner of Barren Island ice-house dock.

Thence referred to a base line through S. .S Station "Van Dalfsen" 177 as origin and "Parson" 155, is described by the following co-ordinates:

Abscissæ.	Ordinates.	
Feet.	*Feet.*	
672	—1,735	Southeast corner of ice-house dock at Barren Island.
2,032	—1,775	North end of the channel face of West Dike.
3,292	—1,748	Angle in the channel face of West Dike.
4,900	—1,405	Interspection of channel face of West Dike and Branch Dike.
5,152	—1,350	

Thence referred to a base line through S. S. Station "Parson" 155 as origin and "Vanderpoel" 181, is described by the following co-ordinates.

Abscissæ.	Ordinates.	
Feet.	*Feet.*	
428	—1,222	South end of channel face of West Dike.
1,638	—1,658	

Which is a point of curve whose radius is 4,166.6 feet; thence along said curve, whose length is 312 feet, to a point of reversed curve which is described by the following co-ordinates:

Abscissa.	Ordinate.
Feet.	*Feet.*
1,836	—963

Thence along a curve to the left, whose radius is 4,166.6 feet and whose length is 1,395 feet, to a point at the end of the curve which is described as follows:

Abscissæ.	Ordinates.	
Feet.	*Feet.*	
2,769	—743	North corner of New Baltimore Dock and
3,894	—588	South corner of a Dock.

Thence referred to a base line through S. S. station "Vanderpoel," 181, as origin and "Stone House," 245, is described as follows:

Abscissa.	Ordinate.	
Feet.	*Feet.*	
433	—590	North corner of a dock.

Which is a point of curve; thence by a curve to the right 1,610 feet whose radius is 8,333.3 feet to a point of tangent whose co-ordinates are—

Abscissæ.	Ordinates.	
Feet.	*Feet.*	
1,831	—713	South corner of dock.
2,312	—668	
3,551	—878	
3,913	—868	South corner of dock.
5,423	—587	North corner of dock.
5,593	—545	South corner of dock.

E 14.

ESTABLISHMENT OF HARBOR LINES OF NEW YORK HARBOR AND ITS ADJACENT WATERS.

a. HARBOR LINES FOR KILL VON KULL AND SHOOTER'S ISLAND.

HARBOR LINE BOARD,
New York City, December 18, 1889.

GENERAL: The Board on Harbor Lines for New York Harbor has the honor to submit a report on pier and bulkhead lines proposed by it for Kill von Kull and Shooter's Island. The report is accompanied by a tracing showing the proposed lines, and a detailed description of them, which are recommended for the approval of the Secretary of War.

Pier and bulkhead lines on the south side of Kill von Kull were established by the State of New York May 26, 1881, Statutes, chapter 363, on the recommendation of a Board, in 1878, composed of Gen. A. A. Humphreys, Chief of Engineers, C. P. Patterson, Superintendent of the Coast Survey, and Lieut. Col. John Newton, Corps of Engineers. This Board also recommended lines for the north side of Kill von Kull, since it was evident that the interests of navigation made the lines on the two sides dependent on each other. Harbor lines for both sides of Kill von Kull had been recommended in 1857 by a Board composed of Gen. J. G. Totten, Chief of Engineers, A. D. Bache, Superintendent of the Coast Survey, and Capt. C. H. Davis, U. S. Navy.

The lines recommended by that Board were adopted by the State of New York, but not by the State of New Jersey. They gave a wider

water-way than those recommended by the Board of 1878. On July 1, 1856, the harbor commissioners of New York attempted to obtain co-operation on the part of New Jersey in the establishment of harbor lines, but without success. Since that date the two States have acted independently on the subject.

The pier-head lines on the two shores recommended by the Board of 1878 nowhere had an interval less than 1,100 feet, and it is to be regretted that this interval was, by the action of the State of New Jersey, subsequently diminished.

On July 12, 1884, the State of New Jersey, through its riparian commission, established a pier-head line which was generally further from land than that recommended by the Board of 1878, already referred to, and which at one place, near Bergen Point, left an interval of but 915 feet between it and the previously established bulkhead lines on the Staten Island side of the channel.

In the interval of time which has elapsed since the establishment of these lines numerous piers have been built out to the pier-head lines on the two sides of the channel, and great injury would now be done to the property owners along the north side of Kill von Kull by requiring the removal of piers already built in order to obtain the width of water-way which once existed and which, in the interests of the great commerce through Kill von Kull, is still desirable. In 1885 the part of this commerce derived from Arthur Kill alone amounted to nearly 6,000,000 tons annually.

In view of the injury which would be done to existing interests, this Board does not now deem it advisable to make any general changes in the pier and bulkhead lines along Kill von Kull as now separately established by the two States, and on the tracing submitted herewith has adopted them with two exceptions.

One of the exceptions is near Bergen Point, where for a distance of about 7,000 feet measured along the pier-head line, the line now recommended by this Board lies nearer to the shore than the line established by the State of New Jersey, the greatest interval between the two being about 270 feet.

This increases the width at the narrowest water-way near Garrison Street, Bergen Point, already referred to, from about 915 feet to 1,100 feet.

Attention is invited to the fact that the State of New Jersey has, under a general law, for consideration, made to individuals or to the City of Bayonne grants of land under water for some portions of this strip already referred to which is about 7,000 feet long, its width varying from nothing to 270 feet.

The interests affected have been heard by the Board, and they oppose the change in the existing lines. It appears that since 1885 the State of New Jersey has inserted in its grants under water a proviso that no claim against New Jersey shall be made by the grantees in consequence of any change made by the United States in the pier and bulkhead lines established by New Jersey, the pier-head line being the limit of these grants under water, but that it did not do so prior to that date. It is not thought that the presence or absence of such a clause in these grants could in any way affect the paramount control by the United States over navigable waters. Nor is it thought that moving this line towards shore will give to the grantees any valid claim for damages against the United States. In the area referred to there are no piers or other existing structures, and the effect of the change of lines is simply to prohibit the erection of such structures therein—a right now vested in the grantees of land under water.

The second change proposed by the Board in existing lines is on the Staten Island side between Franklin Avenue and Davis Avenue, where the pier and bulkhead line can be pushed toward the shore, thus giving increased width of water-way without interfering with any existing structures.

The change covers a strip about 5,000 feet long, varying from 0 to 150 feet in width.

So far as this Board is informed there is no opposition to this change.

In the case of Shooter's Island the owner desires permission to cover the whole of his grant of land under water with solid bulkhead and filling. This Board sees no objection to covering any part of the grant of land under water by piled piers and extending them 600 feet beyond the bulkhead line on the north and east sides, but it approves a bulkhead line covering only a portion of the grant of land under water.

HENRY L. ABBOT,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.,
President of the Board.
WM. P. CRAIGHILL,
Colonel of Engineers.
C. B. COMSTOCK,
Colonel of Engineers,
Bvt. Brig. Gen. U. S. A.
D. C. HOUSTON,
Colonel of Engineers.
G. L. GILLESPIE,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
December 27, 1889.

Respectfully submitted to the Secretary of War.

It appearing that the establishment of harbor lines of New York Harbor is essential to the preservation and protection of the harbor, the Acting Secretary of War by indorsement of October 4, 1888 (papers herewith), approved the recommendation of the Chief of Engineers that the Board of Engineers stationed in New York City be constituted the Board to establish the harbor lines of New York Harbor and its adjacent waters, in accordance with the provisions of section 12 of the river and harbor act of August 11, 1888.

The Board having submitted the within report and accompanying tracing on which the proposed pier-head and bulkhead lines for the north shore of Staten Island, New York, from Westervelt avenue prolonged northerly, New Brighton to the easterly corner of the dike opposite Elizabethport; for the south shore of Bergen Neck, from East Twenty-first street prolonged easterly; Constable's Point to First street prolonged northwesterly; Bergen Point, and around Shooter's Island are drawn, it is recommended that the lines selected be approved and that the approval of the Secretary be placed upon the tracing submitted.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[NOTE.—Approval of the Secretary of War of January 4, 1890, placed upon map accompanying this report.]

DESCRIPTION OF THE HARBOR LINES.

The pier-head and bulkhead lines for the north shore of Staten Island, New York, from Westervelt avenue prolonged northerly, New Brighton to the easterly corner of the dike opposite Elizabethport, are described as follows:

Beginning at a point on the east line of Westervelt avenue produced northerly 280 feet from the south line of shore-road leading from New Brighton Landing to Tompkinsville Landing, called Richmond Terrace, and continuing westerly to a point on the east line of Jersey street produced northerly 336 feet from the south line of said shore-road; thence continuing westerly to a point on the east side of Franklin avenue produced northerly 250 feet from the south line of said shore-road; thence continuing and curving westerly on a curve having a radius of 2,400 feet to a point on the west line of Lafayette avenue produced northerly 255 feet from the south line of said shore-road; thence continuing westerly on a curve having a radius of 2,060 feet to a point on the east line of Clinton avenue produced northerly 345 feet from the south line of said shore-road; thence continuing westerly to a point on the west line of the ferry landing produced 215 feet northerly from said shore-road; thence continuing westerly on a curve having a radius of 4,900 feet to a point on the east line of Bard avenue produced northerly 185 feet from the north line of said shore-road; thence continuing westerly to a point on the east line of Davis avenue produced northerly 253 feet from the south line of said shore-road; thence continuing westerly to a point on the east line of Bement avenue produced northerly 465 feet from the south line of said shore-road; thence continuing westerly to a point on the east line of Elm court produced northerly 550 feet from the south line of said shore-road; thence continuing westerly to a point on the west line of Van street produced northerly 515 feet from the south line of said shore-road; thence continuing westerly to a point on a line 410 feet west of the east line of Mill road and on the south shore-road, said line being at right angles to the shore-road, and said point being northerly 1,440 feet from the south line of said shore-road; thence continuing westerly to a point on the east line of Rathyen place produced northerly 570 feet from the north line of said shore-road or Richmond Terrace, so-called; thence continuing westerly to a point in the center of the dock at the foot of John street, said point being distant 425 feet at right angles from the south line of said shore-road; thence continuing westerly to a point on the west line of Morning Star road produced northerly 505 feet from the south line of said shore-road; thence continuing westerly to a point on the east line of Houseman avenue produced* northerly 560 feet from the south line of said shore-road; thence continuing westerly to a point on the east line of Union avenue produced northerly 1,092 feet from the south line of said shore-road; thence continuing westerly to a point on the west line of Summerfield avenue produced northerly 1,040 feet from the south line of said shore-road; thence continuing westerly to the center of the long pier at a point distant 725 feet from the south line of said shore-road; thence continuing westerly 1,100 feet to a point 150 feet northerly from a straight line drawn between the said point on the long pier and the northeast corner of the United States dike at the entrance of the Arthur Kill; thence continuing westerly 1,100 feet to a point 210 feet northerly from said straight line; thence continuing westerly to the northeast corner of the said United States dike.

The bulkhead line extends from the east line of Bement avenue to the east line of Broadway, and is 300 feet southerly and parallel to the pier-head line between Elm court and Van street, and 400 feet southerly and parallel to the pier-head line between Van street and Mill road, and 300 feet southerly and parallel to the pier-head line between Mill road and Broadway.

The pier-head and bulkhead lines for the south shore of Bergen Neck, from East Twenty-first street prolonged easterly, Constable's Point to First street prolonged northwesterly, Bergen Point, are described as follows:

The pier-head line begins at a point on the center line of East Twenty-first street prolonged easterly 1,896.12 feet from the center line of avenue M; thence continuing on a tangent bearing S. 61° 22′ W. to a point 552.51 feet; thence continuing on a tangent bearing S. 57° 12′ W. to a point 555.17 feet distant, on the center line of East Eighteenth street prolonged easterly and 1,110.66 feet from the center line of avenue M; thence continuing on said tangent bearing S. 57° 12′ W. 613.76 feet; thence continuing westerly on a curve with a radius of 746.55 feet to a point 468.2 feet; thence continuing on a tangent bearing N. 86° 52′ W. to a point of curve distant 887.65 feet; thence continuing westerly on a curve with a radius of 2,283.68 feet to a point on said curve 411.86 feet distant; thence continuing on a tangent bearing N. 76° 32′ W. to a point on the center line of avenue K prolonged southerly 887.04 feet from the center line of East Eighteenth street; thence continuing on said tangent bearing N. 76° 32 W. to a point on the center line of Avenue J prolonged southerly 897.41 feet from the

* The line between John street and Houseman avenue, produced, was modified by the Secretary of War August 15, 1890, so as to run on a straight line between the points above mentioned.

center line of East Eighteenth street; thence continuing on said tangent bearing N. 76° 32′ W. to a point of curve 976.81 feet distant; thence continuing westerly on a curve with a radius of 3,000 feet to a point 1,782.85 feet distant; thence continuing on a tangent bearing S. 69° 25′ W., 2,123.86 feet to a point on the center line of Ingham avenue prolonged southerly 250 feet from monument at the intersection of Ingham avenue and First street; thence continuing westerly to a point on the center line of Avenue S prolonged southerly 350 feet from the monument at the intersection of Avenue S and First street; thence continuing westerly to a point on the center line of Garretson street prolonged southerly 335.69 feet from the monument at the intersection of Garretson street and First street; thence continuing westerly to a point on the center line of Van Horn street prolonged southeasterly 810 feet from the monument at the intersection of Van Horn street and avenue A; thence continuing westerly on a curve with a radius of 1,100 feet to a point on the west side of Avenue A prolonged southerly; thence continuing northwesterly on a curve with a radius of 800 feet to a point on the center line of Van Horn street prolonged northwesterly 718 feet from the monument at the intersection of Van Horn street and Avenue A; thence continuing northwesterly on a tangent to the aforesaid curve to a point 200 feet distant; thence continuing northerly on a curve with a radius of 1,910 feet to a point on the south line of First street prolonged westerly and 1,800 feet from the easterly line of Avenue B.

The bulkhead line begins at a point on a tangent bearing S. 61° 22′ W. 563.68 feet to a point on the center line of East Twenty-first street prolonged easterly and 1,380.18 feet from the center line of Avenue M; thence continuing on the said tangent bearing S. 61° 22′ W. to a point on the center line of East Eighteenth street prolonged easterly and 535.18 feet from the center line of Avenue M; thence continuing on the said tangent to a point of curve 189.45 feet distant; thence continuing westerly on a curve with a radius of 2,083.68 feet to a point 1,700.76 feet distant; thence continuing westerly on a tangent to aforesaid curve bearing N. 71° 52′ W. 376.29 feet to a point on the center line of Avenue K prolonged southerly and 649.5 feet from the center line of East Eighteenth street; thence continuing westerly on the aforesaid tangent bearing N. 71° 52′ W. 972.43 feet to a point on the center line of Avenue J prolonged southerly and 580.75 feet from the center line of East Eighteenth street; thence still continuing on the aforesaid tangent bearing N. 71° 52′ W. 275 feet to a point of curve; thence continuing on a curve with a radius of 4,274.24 feet to a point on the first wharf of the Port Johnson Coal Wharves; this point is 54 feet back from the front face of the wharf and 3 feet from the northeasterly face of the wharf, the distance being measured at right angles to the faces; thence continuing on a line bearing S. 67° 02′ W. 2,138.9 feet to a point at the northeast corner of Enyard's Wharf, said point being on a line bearing N. 82° 50′ W., and 256.6 feet to the intersection of said line with the center line of Ingham avenue, said point of intersection being 86.53 feet from the monument at the intersection of Ingham avenue and First street; thence continuing along said Enyard's Wharf to a point on the center line of Ingham avenue prolonged southerly, and 100 feet from the monument at the intersection of Ingham avenue and First street; thence continuing westerly to a point on the west line of Avenue U prolonged southerly 59.8 feet from the south line of First street; thence continuing westerly to a point on the center line of Avenue S prolonged southerly 149.54 feet from the monument at the intersection of Avenue S and First street; thence continuing westerly to a point on the center line of Garretson street prolonged southerly 335.69 feet from the monument at the intersection of Garretson street and First street; thence continuing westerly to a point on a line drawn at an angle of 132° 20′ to the center line of Van Horn street, and 281.47 feet therefrom, the point of intersection being 239.08 feet from the monument at the intersection of Van Horn street and Avenue A; thence continuing westerly and northerly on a curve with a radius of 679.34 feet to a point on a line drawn through the center of said curve and making an angle of 66° 42′ with the westerly side of Avenue A; thence continuing northerly on a curve with a radius of 2,957 feet to a point on the south line of First street prolonged westerly and 1,600 feet from the east line of Avenue B.

The pier-head and bulkhead lines around Shooter's Island are described as follows:

Description of the pier-head line.—Beginning at a point in the south line of the present bulkhead of Shooter's Island, marked A on the map, S. 88° 44′ E. 1,450 feet; thence running N. 5° 54′ E. 909 feet; thence running N. 65° 20′ W. 1,800.46 feet; thence running S. 5° 18′ W. 1,405.17 feet; thence running S. 44° 45′ E. 316.79 feet to the point or place of beginning.

Description of the bulkhead line.—Beginning at the aforesaid point in the south line of the present bulkhead, marked A on the map, thence running S. 88° 44′ E. 1,450 feet; thence running N. 5° 54′ E. 100 feet; thence running N. 88° 44′ W. 600 feet; thence running N. 5° 54′ E. 426.98 feet; thence running N. 65° 20′ W. 957.34 feet; thence running S. 71° 50′ W. 210.3 feet; thence running S. 5° 13′ W. 617.64 feet; thence running S. 44° 45′ E. 316.79 feet to the point or place of beginning.

b. HARBOR LINES FOR EAST SHORE OF EAST RIVER, NEW YORK, FROM FOOT OF BROADWAY, BROOKLYN, TO RAVENSWOOD, LONG ISLAND.

HARBOR LINE BOARD,
New York City, January 27, 1890.

GENERAL: The Board of Engineers for Harbor Lines of New York Harbor, constituted by Special Orders, No. 49, headquarters Corps of Engineers, October 5, 1888, has the honor to report that at the meeting held in this city January 22, 1890, the following resolution was adopted, referring to proposed harbor lines on the easterly shore of East River, New York, extending from the foot of Broadway, Brooklyn, E. D., to Ravenswood, Long Island:

Resolved, That the present legal pier-head and bulkhead lines on the easterly shore of East River, from Broadway Ferry, Brooklyn, to the eastern end of the pier line at Ravenswood, established by the laws of the State of New York, chapter 536, June 15, 1889, be recommended to the Secretary of War; and that Colonel Gillespie be requested to prepare a map and definition of said lines for action at this meeting of the Board.

The Board has considered and adopted for recommendation a greater length of the shore-line than embraced between the limits mentioned in this resolution, but as it has credible information that private parties are now endeavoring to obtain legislation at Albany providing for an objectionable outward extension of the harbor lines in the vicinity of Bushwick Creek, Brooklyn, it has been deemed best to submit at once a separate report upon these lines so that the action of the Secretary of War may forestall that of the parties seeking new legislation by the State.

The lines now submitted to the Secretary of War for his adoption and approval are described as follows:

1. *From Broadway, Brooklyn, to North Tenth street, Williamsburgh, Long Island.*—The harbor lines on this front are those recommended by the New York Harbor Commission January, 1856, and enacted by chapter 763, Acts of Legislature of the State of New York, passed April 17, 1857.

The report of the commission describes the lines as follows:

"That the bulkhead line follow the 18-foot curve of depth of water as laid down on Map No. 1, East River," and "that the exterior line extend two hundred and fifty feet outside of the bulkhead line."

2. *From North Tenth street, Williamsburgh, Long Island, to Bushwick Creek.*—These lines were enacted by chapter 334, act of legislature of the State of New York, passed April 29, 1873, to conform "with the map entitled Map of Water Fronts on East River, at Bushwick Inlet, Brooklyn, E. D.," made by D. Rosa, city surveyor, which was filed in the office of the secretary of state on the 5th of June, 1865.

From a copy of the D. Rosa map on file with the Harbor Line Board the following description of the enacted lines is made:

Beginning at a point on the bulkhead line adopted in 1857 in the west line of North Tenth street, Williamsburgh, prolonged northerly 803 feet from the north side of First street; thence running in a straight line to a point in the west side of North Eleventh street prolonged northerly 888 feet from the north side of First street; thence running in a straight line to a point in the west line of North Twelfth street prolonged northerly 988 feet from the north side of First street; thence running in a curve to a point in the west line of North Thirteenth street prolonged northerly 872 feet from the north side of First street; thence running in a straight line to a point in a line parallel to the west side of North Thirteenth street prolonged northerly and 38.5 feet therefrom and 733 feet from the north side of First street; thence running in a straight line to a point in a line parallel to the west side of North Thirteenth street and 93 feet therefrom and 529.5 feet from the north side of First street; thence running in a straight line to a point in a line parallel to the west line of North Thirteenth street and 135.5 feet therefrom and 317.5 feet from the north side of First street; thence running in a straight line to a point in a line parallel to the west side of North Thirteenth street and 166 feet therefrom and 125 feet from the north side of First street.

The pier-head line begins at a point on the pier-head line adopted in 1857, in the west line of North Tenth street prolonged northerly 1,065 feet from the north side of First street; thence running in a straight line to a point in the west side of North

Eleventh street prolonged northerly 1,154 feet from the north side of First street; thence running in a curve to a point in the west line of North Twelfth street prolonged northerly 1,180 feet from the north side of First street; thence running in a curve to a point in the west line of North Thirteenth street prolonged northerly 872 feet from the north side of First street, where it joins the bulkhead line described above.

3. *From the east side of Bushwick Creek to the north side of Calyer street, Greenpoint.*—These lines are the same as enacted by chapter 763, act of the legislature of the State of New York, passed April 17, 1857.

4. *From north side of Calyer street to the South side of Box street, Greenpoint.*—These lines were enacted by chapter 628, act of legislature of the State of New York, passed June 14, 1886, and are described as follows:

Beginning at a point on the pier line, as now established by law, at the point where the northerly line of Calyer street prolonged intersects the present pier line; thence running northwesterly on a curved line to a point on the southerly line of Oak street prolonged distant 32 feet westerly from the present pier line; thence northerly on a curved line to a point on the southerly line of Noble street prolonged distant 133 feet westerly from the present pier line; thence northerly on a curved line to a point on the southerly line of Milton street prolonged distant 205 feet westerly from the present pier line; thence northerly on a curved line to a point on the southerly line of Greenpoint avenue prolonged distant 245 feet westerly from the present pier line; thence northerly on a curved line to a point on the southerly line of Kent street prolonged 250 feet westerly from the present pier line; thence northerly on a curved line to a point on the southerly line of Java street prolonged 225 feet westerly from the present pier line; thence northerly on a curved line to a point on the southerly line of India street prolonged 175 feet westerly from the present pier line; thence northerly on a curved line to a point on the southerly line of Huron street prolonged 115 feet westerly from the present pier line; thence northerly on a curved line to a point on the southerly line of Green street prolonged 82 feet westerly from the present pier line; thence northerly on a curved line to a point on the southerly line of Freeman street prolonged 73 feet westerly from the present pier line; thence northeasterly on a curved line to a point on the southerly line of Eagle street prolonged 60 feet westerly from the present pier line; thence northeasterly on a curved line to a point on the southerly line of Dupont street prolonged 43 feet westerly from the present pier line; thence northeasterly in a curved line until it meets the present pier line in the intersection of the southerly line of Box street prolonged with the present pier line.

5. *Newtown Creek to First street, Long Island City.*—These lines were enacted by chapter 224, act of legislature of the State of New York, passed May 8, 1878, and are described as follows:

The pier and bulkhead lines on the Brooklyn side of Newtown Creek will begin at a point situated at the extremity of a line parallel to and 200 feet to the eastward of the easterly line of Duck street, 430 feet from the intersection of said line with the northerly line of Paidge avenue, and running thence* (N. 65° E. 45′ W.) 1,253 feet, intersecting the easterly line of Pequod street 475 feet from the northeast corner of Paidge avenue and Pequod street; thence north (N. 71° 50′ W.) 260 feet, intersecting the easterly line of Shawnett street 461 feet from the northeast corner of Paidge avenue and Shawnett street; thence north (N. 74° 3′ W.) 480 feet, intersecting the westerly line of Oakland street 221 feet from the northwest corner of Ash and Oakland streets; thence north (N. 79° 40′ W.) 263 feet; thence north (N. 86° 10′ W.) 93 feet; thence south (S. 89° 30′ W.) 115 feet; thence south (S. 84° 39′ W.) 268 feet, intersecting the easterly line of Union avenue 376 feet from the northeast corner of Union avenue and Ash street; thence south (S. 82° 55′ W.) 119 feet; thence south (S. 79° 36′ W.) 148 feet; thence south (S. 74° 38′ W.) 85 feet, at which point the line connects with the line recommended by the special Board for the revision of pier and bulkhead lines in 1875. The pier line continuing from this last point runs south (S. 56° 26′ W.) 440 feet to its intersection with the easterly line of Ann street, 505 feet from the northeast corner of Ann and Commercial streets; thence south (S. 55° 54′ W.) 523 feet to its intersection with the easterly line of Pink street 524 feet from the northeast corner of Pink and Commercial streets; thence along a gentle curve tangent to the last-mentioned course and intersecting the southerly line of Clay street 1,026 feet from its intersection with the easterly line of Franklin avenue, the southerly line of Dupont street 1,278 feet from its intersection with the easterly line of Franklin avenue and the southerly line of Eagle street 1,438 feet from its intersection with the easterly line of Franklin avenue.

The new pier and bulkhead line on the Long Island City side of the creek from its point of beginning to where it connects with the line recommended by the special Board in 1875 is parallel to and 250 feet distant from the line on the opposite side of the creek, and is described as follows:

Beginning at a point laying in the prolongation of the westerly line of Hayward

*Act in error; the correct bearing is N. 65° 45′ W.

street 718 feet distant from its intersection with the southerly line of Borden avenue as at present built; thence north (N. 79° 49′ W.) 289 feet; thence north (N. 85° 10′ W.) 113 feet; thence south (S. 89° 30′ W.) 136 feet; thence south (S. 84° 39′ W.) 285 feet, intersecting the westerly line of Vernon avenue 148 feet from the southwest corner of Vernon avenue and Flushing street,* (82° 55′ W.) 132 feet; thence south (S. 79° 36′ W.) 169 feet; thence south (S. 74° 38′ W.) 208 feet, to its intersection with the easterly line of West avenue 318 feet from the southeast corner of West avenue and Flushing street, at which point the line connects with and thereafter follows the line recommended by the special Board in 1875; continuing from this last point the line runs south (S. 36° 6′ W.) 610 feet; thence south (S. 63° 50′ W.) 1,170 feet to the East River exterior line; thence up the East River along a gentle curve, intersecting the southerly line of Pier street 509 feet from the southwest corner of Pier and River streets, the southerly line of Duck street 499 feet from the southwest corner of Duck and River streets, the southerly line of Pidgeon street 740 feet from the southwest corner of Pidgeon and Front streets, the southerly line of Flushing street 711 feet from the southwest corner of Flushing and Front streets, and the southerly line of First street 671 feet from the southwest corner of First and Front streets.

The above is a description of the new pier and bulkhead lines.

6. *From First street, Long Island City, to the vicinity of Nott avenue, Ravenswood, Long Island.*—These lines were enacted by chapter 536, act of the legislature of the State of New York, passed June 15, 1889, and are described as follows:

Beginning at the termination of the line established by chapter 224 of the laws of 1878, at the southerly line of First street 671 feet from the southwest corner of First and Front streets, in Long Island City, and 200 feet outside of the bulkhead and pier line established by chapter† 367 of the laws of 1857; thence up the East River intersecting the southerly line of Second street 155 feet outside of the said pier line of 1857, the southerly line of Third street 132 feet outside of the said pier line, the southerly line of Fourth street 120 feet outside of said pier line, the southerly line of Fifth street 102 feet outside of said pier line, the southerly line of Sixth street 90 feet outside of said pier line, the southerly line of Seventh street 80 feet outside of said pier line, the southerly line of Eighth street 95 feet outside of said pier line, the southerly line of Ninth street 115 feet outside of said pier line, the southerly line of Tenth street 125 feet outside of said pier line, the southerly line of Nott avenue 165 feet outside of said pier line; and thence by the line indicated on said map until it meets the pier line of 1857, at a point 2,000 feet from the southerly line of Nott avenue aforesaid.

Respectfully submitted.

HENRY L. ABBOT,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.,
President of the Board.
WM. P. CRAIGHILL,
Colonel of Engineers.
O. B. COMSTOCK,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.
D. C. HOUSTON,
Colonel of Engineers.
G. L. GILLESPIE,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
February 7, 1890.

Respectfully submitted to the Secretary of War.

The Board of Engineers for Harbor Lines of New York Harbor reports that at a meeting held January 22, 1890, the following resolution was adopted, referring to proposed harbor lines on the easterly shore of

*Act in error; the bearing south is omitted in the act.
† Act in error; correct reading of the chapter is No. 763.

East River, New York, extending from the foot of Broadway, Brooklyn, E. D., to Ravenswood, Long Island:

Resolved, That the present legal pier-head and bulkhead lines on the easterly shore of East River, from Broadway Ferry, Brooklyn, to the eastern end of the pier-head line at Ravenswood, established by the laws of the State of New York, chapter 536, June 15, 1889, be recommended to the Secretary of War. * * *

The Board states that it has considered and adopted for recommendation a greater length of the shore-line than is embraced between the limits mentioned in this resolution, but as it has credible information that private parties are now endeavoring to obtain legislation at Albany providing for an objectionable outward extension of the harbor lines in the vicinity of Bushwick Creek, Brooklyn, it has been deemed best to submit at once a separate report upon these lines, so that the action of the Secretary of War may forestall that of the parties seeking new legislation by the State. The following lines, described in the within report and indicated on the accompanying map, are accordingly submitted for approval:

1. From Broadway, Brooklyn, to North Tenth street, Williamsburgh, Long Island.
2. From North Tenth street, Williamsburgh, Long Island, to Bushwick Creek.
3. From the east side of Bushwick Creek to the north side of Calyer street, Greenpoint.
4. From north side of Calyer street to the south side of Box street, Greenpoint.
5. Newtown Creek to First street, Long Island City.
6. From First street, Long Island City, to the vicinity of Nott avenue, Ravenswood, Long Island.

It is recommended that the lines proposed by the Board be approved, and that the Secretary place his approval both upon the report and the tracing submitted.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Second indorsement.]

WAR DEPARTMENT, *February* 8, 1890.

Approved.

REDFIELD PROCTOR,
Secretary of War.

---

c. HARBOR LINES FOR THE SHORE OF NEW JERSEY FROM COMMUNIPAW, JERSEY CITY, TO CONSTABLE POINT, BERGEN NECK.

HARBOR LINE BOARD,
New York City, January 27, 1890.

GENERAL: The Board of Engineers for Harbor Lines, New York Harbor, constituted by Special Orders, No. 49, Headquarters Corps of Engineers, October 5, 1888, has the honor to report that at its session held in this city January 23, 1890, the following resolution referring to a provisional change in the existing lines on the shore of New Jersey, extending from Communipaw, Jersey City, to Constable Point, Bergen Neck, was adopted, viz:

Whereas there are propositions before the Board looking to a material modification of the present plan adopted by the riparian commission of New Jersey for improving the water-front along the so-called Jersey Flats, by substituting for said plan an exterior artificial island, which island is inconsistent with said plans:

Resolved, That the line of solid filling defined by the Riparian Commission of New Jersey in 1864–'65 be recommended as the limits beyond which no filling or structure shall be permitted until the whole subject is ready to be presented for the action of the Board and the Secretary of War.

It is the recommendation of the Board that all work of construction beyond the harbor lines adopted by the riparian commission of New Jersey in 1864–'65 for Jersey Flats be at once arrested, so as to give adequate time to the Board for the proper consideration of the plans for the future utilization of the shoal waters on the New Jersey shore known as Jersey Flats.

Up to last year no disposition had been evinced by any private parties or corporations owning or controlling grants of land under water extending out over the flats to take advantage of their grants, excepting the Morris & Cummings Dredging Company and the Point Breeze Ferry and Improvement Company at Palmipaw, New Jersey, and the National Storage Company at Black Tom, near Cavan's Point, New Jersey.

The improvement by solid filling at Palmipaw has already reached the bulkhead line of 1864–'65, and the improvements at Black Tom have reached with solid filling the bulkhead line of 1883.

The accompanying map shows the existing legal lines of 1883 in their relation to those of 1864–'65, and the location and extent of the improvement at Palmipaw and Black Tom.

The Board, in explanation to the preamble to the resolution adopted, would say that the construction of an artificial island of considerable area along the eastern border of Jersey Flats from near Ellis Island to Robbins Reef, would proportionally diminish the tidal prism of the flats, and its construction would be inconsistent with the liberal privileges for solid filling authorized by the riparian commission lines of 1883. If the Board should approve later the construction of such an artificial island, it is certain that the lines of 1883 would be pushed back toward the shore and probably to about the location of the lines adopted in 1864–'65.

When, in accordance with existing legal rights, actual constructions have been made, it is a delicate matter to require their removal; and it is to avoid such a contingency in this case that the Board urges immediate action.

For the Board:

Very respectfully, your obedient servant,

HENRY L. ABBOT,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.,
President of the Board.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
January 30, 1890.

Respectfully submitted to the Secretary of War.

The Board of Engineers for Harbor Lines in New York Harbor recommends that the line of solid filling defined by the riparian commission of New Jersey in 1864–'65 be adopted as the limit beyond which

no filling or structure shall be permitted until the whole subject is ready to be presented for the action of the Secretary of War; this action to be preliminary to a further consideration of the plans for the future regulation of the shoal waters on the New Jersey shore known as Jersey Flats.

The views of the Board are concurred in by me and recommended for approval.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Second indorsement.]

WAR DEPARTMENT, *February* 1, 1890.

Approved as recommended by the Chief of Engineers.

REDFIELD PROCTOR,
Secretary of War.

---

d. HARBOR LINES FOR SOUTH AND WEST SHORES OF STATEN ISLAND FROM FORT WADSWORTH TO ELIZABETHPORT, NEW JERSEY, AND WEST BANK OF ARTHUR KILL FROM PERTH AMBOY TO ELIZABETHPORT, NEW JERSEY.

HARBOR LINE BOARD,
New York City, February 18, 1890.

GENERAL: The Board of Engineers for Harbor Lines of New York Harbor, constituted by special orders No. 49, headquarters Corps of Engineers, October 5, 1888, in continuation of the subject of establishing harbor lines for Staten Island, New York Harbor, contained in reports of June 4, 1889, and December 18, 1889, recommending harbor lines on the east shore, extending from Fort Wadsworth to New Brighton, approved by the Secretary of War June 21, 1889, and on the north shore, approved by the Secretary of War January 24, 1890, has now the honor to present for the approval of the Secretary of War harbor lines on the south and west shores of Staten Island, connecting with the lines already approved, and completing the system around the island; and also harbor lines for the west bank of Arthur Kill from Perth Amboy to Elizabethporth, N. J.

These lines, additional to those previously submitted, are delineated upon the map accompanying this report.

The harbor lines recommended are as follows:

1. From Fort Wadsworth, N. Y., southwestward to a point on west shore of Staten Island, New York, opposite the mouth of Woodbridge creek, New Jersey.

2. From point on west shore of Staten Island opposite Woodbridge Creek to eastern end of Government dike opposite Elizabethport.

3. West bank of Arthur Kill, from foot of Lewis street, Perth Amboy to Elizabethport, N. J.

These lines are fully described in a separate paper forming an inclosure to this report. As there are few prominent objects in the vicinity the Board recommends that permanent monuments be put down

as early as practicable to mark definitely and accurately the base lines from which the harbor lines are laid off.

Respectfully submitted.

HENRY L. ABBOT,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.
WM. P. CRAIGHILL,
Colonel of Engineers.
C. B. COMSTOCK,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.
D. C. HOUSTON,
Colonel of Engineers.
G. L. GILLESPIE,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
March 1, 1890.

Respectfully submitted to the Secretary of War.

The Board for Harbor Lines of New York Harbor, in continuation of the subject of establishing harbor lines for Staten Island, contained in reports of June 4, and December 18, 1889, recommending harbor lines on the east shore and on the north shore, approved by the Secretary of War June 21, 1889, and January 24, 1890, respectively, now submits, for the approval of the Secretary, harbor lines on the south and west shores of Staten Island connecting with the lines already approved, and completing the system around the island; and also harbor lines for the west bank of Arthur Kill from Perth Amboy to Elizabethport, N. J. The lines submitted for approval are fully described in the within inclosure, and delineated on the accompanying chart and are as follows:

1. From Fort Wadsworth, N. Y., southwestward to a point on west shore of Staten Island, New York, opposite the mouth of Woodbridge Creek, New Jersey.

2. From point on west shore of Staten Island opposite Woodbridge Creek, to eastern end of Government dike opposite Elizabethport.

3. West bank of Arthur Kill, from foot of Lewis street, Perth Amboy, to Elizabethport, N. J.

It is recommended that the lines proposed by the Board be approved, and that the Secretary place his approval both upon the report and the tracing submitted.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Second indorsement.]

WAR DEPARTMENT, *March* 4, 1890.

Approved.

REDFIELD PROCTOR,
Secretary of War.

DESCRIPTION OF HARBOR LINES ON THE SOUTH AND WEST SHORES OF STATEN ISLAND, AND FOR THE WEST BANK OF ARTHUR KILL FROM PERTH AMBOY TO ELIZABETHPORT, NEW JERSEY, WHICH ARE RECOMMENDED TO THE SECRETARY OF WAR FOR APPROVAL AND ADOPTION BY THE BOARD OF ENGINEERS FOR HARBOR LINES OF NEW YORK HARBOR, CONSTITUTED BY SPECIAL ORDER 49, HEADQUARTERS CORPS OF ENGINEERS, OCTOBER 5, 1888, IN A REPORT DATED FEBRUARY 18, 1890.

The pier and bulkhead lines for the south and west shores of Staten Island are laid at certain distances from the shore-line and runs from Fort Wadsworth south-

westerly through the Arthur Kill to the dike opposite Elizabethport; it is fixed by offsets from established base lines which join light-houses in the vicinity, chimneys or stakes driven into the ground. The magnetic bearing and length of each base line are written upon the base line.

The pier-head and bulkhead line begins at the southeast corner of the bulkhead in front of Fort Wadsworth, the co-ordinates of said point being referred to the line joining Fort Tompkins Light and Elm Tree Light prolonged northeasterly, the origin of co-ordinates being Fort Thompkins Light, the abscissa is —1,088 feet and the corresponding ordinate +650; thence continuing southerly and southwesterly, the various points of change being fixed by the co-ordinates referred to the base line joining Fort Tompkins and Elm Tree Light whose bearing is S. 39° 29′ 36″ W., and whose length is 18,166.9 feet; the following table gives the abscissæ, with Fort Tompkins Light as the origin and the corresponding ordinates, viz:

Abscissæ.	Ordinates.
Feet.	*Feet.*
+ 215	— 860
+ 4,498*	— 650
+ 6,795	— 575
+12,086	—1,000
+11,855	— 730
+11,995	— 700
+12,251	— 960
+13,976	— 340
+14,939	— 115
+16,323	— 290
+18,044	— 535

* At a point marked "A" on the map (see description of pier-head line, page 805,) the pier-head line departs from the bulkhead line. The bulkhead line continues as follows:

Thence continuing southwesterly along the shore, the points of change being fixed by co-ordinates referred to the base line joining Elm Tree Light and the chimney at Seguine's Point, the bearing of said base line being S. 55° 29′ 39″ W. and its length 33,767.5 feet. The following table gives the abscissæ, with Elm Tree Light as the origin, and the corresponding ordinates, viz:

Abscissæ.	Ordinates.
Feet.	*Feet.*
+ 1,333	—1,065
+12,370	—3,980
+12,862	—4,095
+13,358	—4,145
+13,860	—4,120
+14,347	—4,025
+14,801	—3,855
+15,213	—3,540
+15,158	—3,040
+14,932	—2,175
+15,654	— 670
+16,315	—1,115
+16,816	—1,210
+18,333	—1,015
+18,843	—1,015
+20,986	—1,215
+22,949	— 890
+25,393	— 815
+25,703	— 520
+26,148	— 290
+26,660	— 280
+27,165	— 350
+27,662	— 335
+28,147†	— 190
+28,453	+ 215
+28,933	+ 375
+29,439	+ 390
+29,940	+ 295
+30,426	+ 100
+32,694	— 755
+33,189	— 840
+33,635	— 620

† At this point the line continues south as a pier-head and bulkhead line.

ıce continuing southwesterly along Princess Bay, the points of change being fixed o-ordinates referred to the base line joining the chimney at Seguine's Point and cess Bay Light, bearing S. 76°. 18′ 16″ W. and its length 4,999.3 feet. The folng table gives the abscissæ with the chimney as the origin, and the correspondrdinates, viz:

Abscissæ.	Ordinates.
Feet.	*Feet.*
+ 125	—300
+ 600	+140
+1,030	+400
+1,515	+565
+1,995	+510
+2,480	+840
+2,980	+885
+3,484	+775
+3,880	+460
+4,205	+ 80
+4,595	—240

ıce continuing southwesterly along the shore, the points of change being fixed by rdinates referred to, the base line joining Princess Bay Light and Station I of the : at Ward's Point, located by sextant angles from various fixed points, as are also following successive stations, bearing S. 70° 29′ 23″ W. and its length 11,451.7

The following table gives the abscissæ with Princess Bay Light as the origin, the corresponding ordinates, viz:

Abscissæ.	Ordinates.
Feet.	*Feet.*
+ 75	— 520
+ 1,605	—1,180
+ 2,095	—1,265
+ 2,600	—1,275
+ 3,100	—1,235
+ 3,605	—1,160
+ 4,710	— 840
+ 5,195	— 720
+ 5,705	— 700
+ 6,205	— 745
+ 6,705	— 845
+ 7,175	—1,010
+ 7,820	—1,275
+ 8,325	—1,365
+ 8,825	—1,450
+ 9,330	—1,460
+ 9,830	—1,395
+10,315	—1,250
+10,770	—1,040
+11,160	— 710
+11,365	— 430

ıce continuing northwesterly to a point in the aforesaid base line (Princess Bay Station I) prolonged southwesterly and 40 feet from Station I; thence continuing hwesterly and parallel to the base-line adjoining Stations I and II, bearing N. 7′ 8″ W., and whose length is 2,787.6 feet, and at 40 feet therefrom to a point in e at right angles to the aforesaid base line at Station II; thence continuing northerly along the shore of the Arthur Kill, the points of change being fixed by conates referred to the base line joining Stations II and III, bearing N. 4° 15′ 9″ E. its length 1,497.5 feet. The following table gives the abscissæ with Station II as origin, and the corresponding ordinates, viz:

Abscissæ.	Ordinates.
Feet.	*Feet.*
+ 465	—170
+ 975	—175
+1,470	—110

nce continuing northeasterly along the shore of Arthur Kill, the points of change g fixed by co-ordinates referred to the base line joining Stations III and IV, bearing

N. 35° 5′ 53″ E. and its length 3,049.4 feet. The following table gives abscissæ with Station III as the origin and the corresponding ordinates, viz:

Abscissæ.	Ordinates.
Feet.	*Feet.*
+1,000	−490
+1,495	−575
+2,000	−550
+2,490	−430

Thence continuing northeasterly along the shore of the Arthur Kill, the points of change being fixed by co-ordinates referred to the base line adjoining Station IV and V, bearing N. 23° 52′ 52″ E. and its length 3,941.4 feet. The following table gives the abscissæ with Station IV as the origin and the corresponding ordinates, viz:

Abscissæ.	Ordinates.
Feet.	*Feet.*
+ 855	+235
+1,315	+430
+1,800	+545
+2,300	+530
+2,785	+380

Thence continuing northeasterly along the shore of the Arthur Kill, the points of change being fixed by co-ordinates referred to the base line adjoining Station V and VI, bearing N. 11° 32′ 55″ E. and its length 2,629.2 feet. The following table gives the abscissæ with Station V as the origin and the corresponding ordinate, viz:

Abscissæ.	Ordinate.
Feet.	*Feet.*
+1,435	−630

Thence continuing north-westerly along the said shore, the points of change being fixed by co-ordinates referred to the base line joining Stations VI and VII, bearing N. 19° 24′ 38″ W. and its length 3,889.0 feet. The following table gives the abscissæ with Station VI as the origin and the corresponding ordinates, viz:

Abscissæ.	Ordinates.
Feet.	*Feet.*
+ 256	−923
+1,248	−960
+2,242	−840
+3,220	−785
+3,702	−662
+3,889.0	−580

Thence continuing northeasterly along the said shore, the points of change being fixed by co-ordinates referred to the base line joining Stations VII and X, bearing N. 40° 2′ 30″ E. and its length 4,404.3 feet. The following table gives the abscissæ with Station VII as the orgin and the corresponding ordinates, viz:

Abscissæ.	Ordinates.
Feet.	*Feet.*
+ 0	−575
+ 420	−725
+ 891	−805
+1,383	−860
+1,883	−773
+2,390	−732
+2,875	−680
+3,375	−620

Thence continuing northeasterly along the said shore, the points of change being fixed by co-ordinates referred to the base line joining Stations X and XI, bearing N. 50° 56′ 50″ E. and its length 2883.0 feet. The following table gives the abscissæ with Station X as the origin and the corresponding ordinates, viz:

Abscissæ.	Ordinates.
Feet.	*Feet.*
+1,380	—540
+2,012	—475
+2,512	—310
+2,883.0	— 95

Thence continuing northeasterly along the said shore, the points of change being fixed by co-ordinates referred to the base line joining Stations XI and XIII, bearing N. 89° 4′ 51″ E. and its length 3,945.0 feet. The following table gives the abscissæ with Station XI as the origin and the corresponding ordinates, viz:

Abscissæ.	Ordinates.
Feet.	*Feet.*
+ 45	— 70
+ 533	+ 95
+ 999	+235
+1,505	+345
+2,255	+325
+2,750	+215
+3,210	— 20
+3,590	—300

Thence continuing northeasterly along the said shore, the points of change being fixed by co-ordinates referred to the base line joining Stations XIII and XIV, bearing N. 13° 42′ 50″ E. and its length 2,636.3 feet. The following table gives the abscissæ with Station XIII as the orgin and the corresponding ordinates, viz:

Abscissæ.	Ordinates.
Feet.	*Feet.*
+ 500	—235
+ 860	—105
+1,850	— 20
+2,636.3	—110

Thence continuing northeasterly along the said shore, the points of change being fixed by co-ordinate referred to the base line joining Stations XIV and XV, bearing N. 18° 06′ 15″ E., and its length 2,786.9 feet. The following table gives the abscissæ with Station XIV as the origin and the corresponding ordinates, viz:

Abscissæ.	Ordinates.
Feet.	*Feet.*
+ 190	—160
+ 680	—225
+1,680	—290
+2,500	—285
+2,712	—230

Thence continuing northeasterly along the said shore, the points of change being fixed by co-ordinates referred to the base line joining Stations XV and XVII, bearing N.

8° 31′ 00″ E., and its length 1,801.4 feet. The following table gives the abscissæ with Station XV as the origin and the corresponding ordinates, viz:

Abscissæ.	Ordinates.
Feet.	*Feet.*
+ 150	—133
+ 288	0
+ 445	+ 200
+ 740	+ 155
+ 740	0
+ 805	— 85
+ 935	— 145
+1,801.4	— 165

Thence continuing northeasterly along the said shore, the points of change being fixed by co-ordinates referred to the base line joining Stations XVII and XVIII, bearing N. 10° 40′ 20″ E., and its length 1,395.9 feet. The following table gives the abscissæ with Station XVII as the origin and the corresponding ordinates, viz:

Abscissæ.	Ordinates.
Feet.	*Feet.*
+ 665	—145
+ 815	—135
+ 975	— 70
+1,140	+ 45
+1,315	— 50

Thence continuing northeasterly along the said shore, the points of change being fixed by co-ordinates referred to the base line joining Stations XVIII and XX, bearing N. 11° 20′ 59″ E., and its length 3,859.1 feet. The following table gives the abscissæ with Station XVIII as the origin and the corresponding ordinates, viz:

Abscissæ.	Ordinates.
Feet.	*Feet.*
+ 60	—100
+ 590	—120
+2,040	—110
+3,025	—230
+3,525	—230
+3,859.1	—160

Thence continuing northeasterly along the said shore, the points of change being fixed by co-ordinates referred to the base line joining Stations XX and XXII, bearing N. 23° 56′ 18″ E., and its length 4,833.6 feet. The following table gives the abscissæ with Station XX as the origin and the corresponding ordinates, viz:

Abscissæ.	Ordinates.
Feet.	*Feet.*
+ 140	—110
+ 575	± 0
+1,275	+155
+1,780	+230
+2,160	+290
+2,722	+285
+3,170	+220
+3,710	+105
+4,115	+ 35
+4,520	± 0
+4,833.6	— 50

Thence continuing northeasterly along the said shore, the points of change being fixed by co-ordinates referred to the base line joining Stations XXII and XXIII,

bearing N. 2° 15′ 40″ E., and its length 2,844.3 feet. The following table gives the abscissæ with Station XXII as the origin, and the corresponding ordinates, viz:

Abscissæ.	Ordinates.
Feet.	*Feet.*
+ 315	± 0
+ 545	± 0
+ 655	— 30
+ 910	—145
+1,310	—395
+1,660	—645
+1,815	—700
+1,950	—725
+2,165	—730
+2,455	—665
+2,580	—615
+2,755	—520

Thence continuing northeasterly along the said shore, the points of change being fixed by co-ordinates referred to the base line joining Stations XXIII and XXIV, bearing N. 1° 55′ 45″ E., and its length 3,121.9 feet. The following table gives the abscissæ with Station XXIII as the origin and the corresponding ordinates, viz:

Abscissæ.	Ordinates.
Feet.	*Feet.*
+ 125	— 385
+ 270	— 295
+ 450	— 205
+ 660	— 130
+ 945	— 60
+1,160	— 30
+1,330	— 15
+1,520	— 45
+1,590	— 80
+1,750	— 175
+1,880	— 300
+1,995	— 480
+2,345	—1,300
+2,405	—1,395
+2,475	—1,470
+2,740	—1,595

Thence continuing northeasterly along the said shore, the points of change being fixed by co-ordinates referred to the base line joining Stations XXIV and XXV, bearing N. 4° 41′ 10″ E., and its length 3,151.3 feet. The following table gives the abscissæ with Station XXIV as the origin and the corresponding ordinates, viz:

Abscissæ.	Ordinates.
Feet.	*Feet.*
+ 250	—1,710
+1,055	—1,825
+1,780	—1,885
+2,190	—1,850
+2,720	—1,790
+3,151.3	—1,800

Thence continuing northeasterly along the said shore, the points of change being fixed by co-ordinates referred to the base line joining Stations XXV and XXVI, bear-

ing N. 36° 2′ 55″ E., and its length 2,082.8 feet. The following table gives the abscissæ with Station XXV as the origin and the corresponding co-ordinates, viz:

Abscissæ.	Ordinates.
Feet.	*Feet.*
+ 20	—2,100
+ 330	—2,240
+ 640	—2,265
+ 890	—2,240
+1,445	—2,140
+1,905	—2,130

Thence continuing northeasterly along the said shore, the points of change being fixed by co-ordinates referred to the base line joining Stations XXVI and XXVII, bearing N. 41° 12′ 55″ E., and its length 4,198.8 feet. The following table gives the abscissæ with Station XXVI as the origin and the corresponding co-ordinates, viz:

Abscissæ.	Ordinates.
Feet.	*Feet.*
+ 235	—2,220
+ 830	—2,360
+1,435	—2,405
+2,080	—2,375
+2,540	—2,320
+2,850	—2,275
+3,485	—2,165
+4,015	—2,100
+4,198.8	—2,090

Thence continuing northeasterly along the said shore, the points of change being fixed by co-ordinates referred to the base line joining Stations XXVII and XXVIII, bearing N. 53° 2′ 50″ E., and its length 1,647.4 feet. The following table gives the abscissæ with Station XXVII as the origin and the corresponding co-ordinates, viz:

Abscissæ.	Ordinates.
Feet.	*Feet.*
.....	—2,105
+ 160	—2,085
+ 370	—2,005
+ 765	—1,730
+1,180	—1,395
+1,590	—1,025

The exterior line around Chelsea Island is described as follows:

Begins at the extreme southerly point and runs north along both shores of the island; the points of change are fixed by co-ordinates referred to base lines joining the following stations, viz: Stations XX and XXII, bearing N. 23° 56′ 18″ E., and its length 4,833.6 feet. Stations XXII and XXIII, bearing N. 2° 15′ 40″ E., and its length 2,844.3 feet; and Stations XXIII and XXIV, bearing N. 1° 55′ 45″ E., and its length 3,121.9 feet as before mentioned; the following tables give the abscissæ referred to their respective origins and the corresponding ordinates, viz:

Base line Stations XX and XXII, with Station XX as the origin.

Abscissæ.	Ordinates.	
Feet.	*Feet.*	*Feet.*
+4,180	—495	
+4,230	—605 and	—430
+4,570	—900 and	—415
+4,833.6	—430	

Base line Stations XXII and XXIII, with Station XXII as the origin.

Abscissæ.	Ordinates.
Feet.	*Feet.* *Feet.*
+ 295	—1,050 and — 495
+ 480	— 480
+ 655	—1,350 and — 590
+ 910	—1,645 and — 730
+1,310	—2,050 and — 905
+1,660	—2,165 and — 995
+1,950	—2,175 and —1,045
+2,320	—2,150 and —1,075
+2,580	—2,050 and —1,040

Base line Stations XXIII and XXIV, with Station XXIII as the origin.

Abscissæ.	Ordinates.
Feet.	*Feet* *Feet.*
+ 125	—1,990 and — 935
+ 450	—1,965 and — 810
+ 660	—1,965 and — 710
+ 945	—1,970 and — 585
+1,160	— 525
+1,330	—1,955 and — 555
+1,520	— 705
+1,590	—1,910 and — 875
+1,680	—1,870 and —1,100
+1,750	—1,800 and —1,235
+1,845	—1,560

Thence continuing to the northeast corner of the United States dike.

The pier-head line begins at the point marked "A" on the map, being the intersection of the above-described pier and bulkhead line and a line drawn from the point of intersection of the south boundary line United States reservation at Fort Tompkins and the west side of the shore-road to the northernmost point of Hoffmann Island; thence along said line towards Hoffmann Island until it meets a point in a line parallel to and 1,500 feet from the described bulkhead line; thence continuing southwesterly parallel to and 1,500 feet from the bulkhead line to a point which is fixed by co-ordinates referred to the base line joining Fort Tompkins and Elm Tree lights, as before mentioned. The following table gives the abscissa, with Fort Tompkins Light as the origin, and the corresponding ordinate, viz:

Abscissa.	Ordinate.
Feet.	*Feet.*
+ 15,714	5,100

Thence continuing northwesterly to a point which is fixed by co-ordinates referred to the same base line as above, viz:

Abscissa.	Ordinate.
Feet.	*Feet.*
+ 14,932	2,175

Beginning at a point on the westerly side of Great Kills Entrance which is fixed by co-ordinates referred to the same base line as above, viz:

Abscissa.	Ordinate.
Feet.	*Feet.*
+ 15,604	670

Thence continuing to a point which is fixed by co-ordinates referred to the same base line as above, viz:

Abscissa.	Ordinate.
Feet.	*Feet.*
+17,836	—2,610

Thence parallel to and 1,500 feet from the bulkhead line as described to a point marked B on the map, about 1 mile northeast of Seguine's Point.

The pier line for the westerly shore of Arthur Kill between Lewis street, Perth Amboy, and the northern limit of the wharves of the Central Railroad of New Jersey at Elizabethport is described as follows:

Beginning at a point opposite the foot of Lewis street, Perth Amboy, whose abscissa, referred to the base line joining Stations I and II the bearing of which is N. 20° 7′ 8″ W. and its length 2,787.6 feet with Station I as the origin, is 2,300 feet, and the ordinate —2,980 feet; thence northeasterly along the westerly shore of Arthur Kill to a point at right angles to the said base line, produced, 210 feet beyond Station II, and the ordinate of which is 2,000 feet; thence continuing northeasterly along the said shore, the point of change being fixed by co-ordinates referred to the base line joining Stations I and III, bearing N. 4° 15′ 09″ E. and its length 1,497.5 feet. The following table gives the abscissæ with Station II as the origin and the corresponding ordinates:

Abscissæ.	Ordinates.
Feet.	*Feet.*
+ 800	—1,680
+1,400	—1,600

Thence continuing northeasterly along the westerly shore of Arthur Kill, the points of change being fixed by co-ordinates referred to the base line joining Stations III and IV, bearing N. 35° 05′ 53″ E. and its length 3,039.04 feet. The following table gives the abscissæ with Station III as the origin and the corresponding ordinates, viz:

Abscissæ.	Ordinates.
Feet.	*Feet.*
— 60	—1,600
+1,000	—1,910

Thence continuing northeasterly along the said shore, the points of change being fixed by co-ordinates referred to the base line joining Stations IV and V, bearing N. 23° 52′ 52″ E. and its length 3941.4 feet. The following table gives the abscissæ with Station IV as the origin and the corresponding ordinates, viz:

Abscissæ.	Ordinates.
Feet.	*Feet.*
+1,650	—1,290
+2,300	—1,210

Thence continuing northerly in a curved line along the said shore through a point which is fixed by co-ordinates referred to the base line joining Stations V and VI, bearing N. 11° 32′ 52″ E. and its length 2,629.2 feet. The following table gives the abscissa with Station V as the origin and the corresponding ordinate, viz:

Abscissa.	Ordinate.
Feet.	*Feet.*
0	—1,860

Thence continuing northwesterly in a curved line along said shore to the mouth of Woodbridge Creek through points which are fixed by co-ordinates referred to the base line joining Stations VI and VII, bearing N. 19° 24′ 38″ W. and its length 3889.0 feet. The following table gives the abscissæ with Station VI as the origin and the corresponding ordinates, viz:

Abscissæ.	Ordinates.
Feet.	*Feet.*
1,248	—2,800
3,220	—2,500
3,702	—2,670

The following points are referred to the same base line produced beyond Station VII, with said Station VII as the origin:

Abscissæ.	Ordinates.
Feet.	*Feet.*
220	—2,800
70	—2,490
220	—2,180
690	—1,880
2,700	—1,510

Thence continuing northeasterly in a curved line along the said shore through points which are fixed by co-ordinates referred to the base line joining Stations VII and X, bearing N. 40° 02′ 30″ E. and its length 4404.3 feet. The following table gives the abscissæ with Station VII as the origin and the corresponding ordinates, viz:

Abscissæ.	Ordinates.
Feet.	*Feet.*
420	—3,240
1,383	—3,390
2,390	—3,300
4,404.3	—2,700

Thence continuing northeasterly in a curved line along the said shore through points which are fixed by co-ordinates referred to the base line joining Stations X and XI, bearing N. 50° 56′ 50″ E. and its length 2,883.0 feet. The following table gives the abscissæ with Station X as the origin and the corresponding ordinates, viz:

Abscissæ.	Ordinates.
Feet.	*Feet.*
2,012	—2,150
2,883	—1,810

Thence continuing in a curved line easterly along the said shore through points which are fixed by co-ordinates referred to the base line joining Stations XI and XIII, bearing N. 89° 04′ 51″ E. and its length 3,955.0 feet. The following table gives the abscissæ with Station XI as the origin, and the corresponding ordinates, viz:

Abscissæ.	Ordinates.
Feet.	*Feet.*
0	—1,480
996	—1,200
1,605	— 900
2,255	— 910

Thence continuing northeasterly in a curved line along the said shore through a point which is fixed by co-ordinates referred to the base line joining Stations XIII and XIV, bearing N. 13° 42′ 50″ E. and its length 2,636.3 feet. The following table gives the abscissæ with Station XIII as the origin and the corresponding ordinate, viz:

Abscissa.	Ordinate.
Feet.	*Feet.*
1,850	—1,260

Thence continuing northeasterly in a curved line along the said shore through a point which is fixed by co-ordinates referred to the base line joining Stations XIV and XV bearing N. 18° 06′ 15″ E., and its length 2,786.9 feet; the following table gives the abscissa with Station XIV as the origin and the corresponding ordinate, viz:

Abscissa.	Ordinate.
Feet.	*Feet.*
680	—1,100

Thence continuing northeasterly in a curved line along the said shore through a point which is fixed by co-ordinates referred to the base line joining Stations XV and XVII, bearing N 8° 31′ 00″ E., and its length 1,801.4 feet; the following table gives the abscissa with Station XV as the origin, and the corresponding ordinate, viz:

Abscissa.	Ordinate.
Feet.	*Feet.*
805	—1,210

Thence continuing northeasterly in a curved line along the said shore through a point which is fixed by co-ordinates referred to the base line joining Stations XVII and XVIII, bearing N. 10° 40′ 20″ E., and its length 1,395.9 feet; the following table gives the abscissa with Stations XVII as the origin, and the corresponding ordinate, viz:

Abscissa.	Ordinate.
Feet.	*Feet.*
1,140	—1,310

Thence continuing northeasterly in a curved line along said shore through points which are fixed by co-ordinates referred to the base line joining Stations XVIII and XX, bearing N. 11° 20′ 59″ E., and its length 3,859.1 feet; the following table gives the abscissæ with Station XVIII as the origin, and the corresponding ordinates, viz:

Abscissæ.	Ordinates.
Feet.	*Feet.*
1,040	—1,240
3,025	—1,290
3,859.1	—1,100

Thence continuing northeasterly in a curved line along the said shore through points which are fixed by co-ordinates referred to the base line joining Stations XX and XXII, bearing N. 23° 56′ 18″ E., and its length 4,833.6 feet, the first two points located being

on opposite sides of the mouth of Rahway River; the following table gives the abscissæ with Station XX as the origin, and the corresponding ordinates, viz:

	Abscissæ.	Ordinates.
	Feet.	*Feet.*
At this point to the dock north of the mouth of Elizabeth River, the harbor lines coincide.	890	—1,330
	1,410	—1,120
	2,160	—680
	3,710	—970

Thence continuing northwesterly in a curved line along the said shore through points which are fixed by co-ordinates referred to the base line joining Stations XXII and XXIII, bearing N. 2° 15′ 40″ E., and its length 2844.3 feet; the following table gives the abscissæ with Station XXII as the origin, and the corresponding ordinates, viz:

Abscissæ.	Ordinates.
Feet.	*Feet.*
0	—1,670
655	—2,450
1,310	—2,710
2,580	—2,600

Thence continuing northerly in a curved line along the said shore through points which are fixed by co-ordinates referred to the base line joining Stations XXIII and XXIV, bearing N. 1° 55′ 45″ E., and its length 3.121.9 feet; the following table gives the abscissæ with Station XXIII as the origin, and the corresponding ordinates, viz:

Abscissæ.	Ordinates.
Feet.	*Feet.*
660	—2,500
1,590	—2,500

Thence continuing northerly in a curved line along the said shore through points which are fixed by co-ordinates referred to the base line joining Stations XXIV and XXV, bearing N. 4° 41′ 10″ E., and its length 3,151.3 feet; the following table gives the abscissæ with Station XXIV as the origin, and the corresponding ordinates, viz:

Abscissæ.	Ordinates.
Feet.	*Feet.*
250	—2,550
1,780	—3,160
2,720	—2,920
3,151.3	—2,680

Thence continuing northeasterly in a curved line along the said shore through points which are fixed by co-ordinates referred to the base line joining Stations XXV and XXVI, bearing N. 36° 02′ 55″ E., and its length 2,082.8 feet; the following table gives the abscissæ with Station XXV as the origin, and the corresponding ordinates, viz:

Abscissæ.	Ordinates.
Feet.	*Feet.*
20	—2,970
640	—3,090
890	—3,400
1,210	—2,810
1,720	—2,680

thence continuing northeasterly along the said shore, the points of change being fixed by co-ordinates referred to the base line joining Stations XXVI and XXVII, bearing

N. 41° 12′ 55″ E., and its length 4,198.8 feet; the following table gives the abscissæ with Station XXVI as the origin, and the corresponding ordinates, viz:

Abscissæ.	Ordinates.
Feet.	*Feet.*
580	−2,980
1,290	−3,000
3,250	−2,890
4,198.8	−2,700

Thence continuing northeasterly along the said shore to a point which is fixed by co-ordinates referred to the base line joining Stations XXVII and XXVIII, bearing N. 53° 02′ 50″ E., and its length 1,647.4 feet; the following table gives the abscissa with Station XXVII as the origin, and the corresponding ordinate, viz:

Abscissa.	Ordinate.
Feet.	*Feet.*
300	−2,690

thence continuing northeasterly along the said shore to a point which is fixed by co-ordinates referred to the base line last mentioned above, produced beyond Station XXVIII; the following table gives the abscissa with Station XXVIII as the origin and the corresponding ordinate, viz:

Abscissa.	Ordinate.
Feet.	*Feet.*
250	−1,730

thence continuing northeasterly along the said shore to a point on the bulk head at the northern limit of the wharves of the Central Railroad of New Jersey at Elizabethport.

The bulkhead line begins at Lewis street, Perth Amboy, and continues north to Rahway River. It follows the pier-head line at certain distances therefrom which are given on the accompanying map.

The bulkhead line deflects from the pier-head line at the dock north of the mouth of Elizabeth River and follows the general direction of the pier-head line at certain distances from it, as shown on the map, to the railroad pier at the foot of McKensie Place, Elizabethport.

---

e. HARBOR-LINES FOR EAST SHORE OF EAST RIVER, NEW YORK, BUTTERMILK CHANNEL, AND BOTH SHORES OF GOWANUS BAY FROM LAWRENCE POINT TO FORT HAMILTON.

HARBOR LINE BOARD,
New York City, February 18, 1890.

GENERAL: The Board of Engineers for harbor lines of New York Harbor, constituted by Special Orders, No. 49, Headquarters Corps of Engineers, October 5, 1888, has the honor to report that at the meeting held in this city January 23, 1890, the following resolution was adopted referring to proposed harbor-lines on the easterly shore of East River, Buttermilk Channel, Upper New York Bay, and both shores of Gowanus Bay, New York, extending from the foot of Broadway, Brooklyn, E. D., to the northern boundary of the Government land at Fort Hamilton, Long Island:

Resolved, That the present legal pier and bulkhead lines between Broadway Ferry, Brooklyn, and the northern boundary of the Government land at Fort Hamilton, be recommended for approval, except that the pier and bulkhead lines exterior to the

Erie Basin be made coincident with the present bulkhead line there; also that Colonel Gillespie be requested to prepare a map and definitions for the lines thus recommended at as early a date as practicable.

Provided, however, That between Seventeenth street on the south shore of Gowanus Creek and Fort Hamilton the piers between the limits of the pier and bulkhead lines may be filled with solid materials when an equal tidal prism is provided in compensation therefor behind the authorized bulkhead line and adjacent to said piers.

In the report of the Board dated January 27, 1890, recommending for the approval of the Secretary of War "the legal pier-head and bulkhead lines on the easterly shore of East River from Broadway Ferry, Brooklyn, to the eastern end of the pier line at Ravenswood, established by the laws of the State of New York, chapter 536, June 15, 1889," it is stated that the Board had "considered and adopted for recommendation a greater length of the shore-line than embraced between the limits mentioned in the resolution contained in the report of January 27."

The harbor-lines recommended in the report of January 27, 1890, were approved by the Secretary of War February 8, 1990. The Board now presents additional maps covering the space not included in the report of January 27, and completing the harbor-lines on the east side of the East River, and of the Harbor of New York from Lawrence Point, opposite Port Morris to the Narrows.

The lines now submitted to the Secretary of War for his adoption and approval are described as follows:

1. *From Lawrence Point opposite Port Morris to eastern end of pier line at Ravenswood, Long Island.*—The lines on this front were recommended by the State Commissioners of 1857 and established by laws of the State of New York, chapter 763, 1857. The pier-head and bulkhead lines were made coincident, but were never described by the State Commissioners.

An inspection of the chart will give their direction by courses or their distances from the low-water line of the contiguous shore.

2. *From Ravenswood, Long Island, to Broadway Ferry, Brooklyn, E. D.*—This line was recommended to the Secretary of War by the New York Harbor-Line Board January 27, 1890, for adoption, and was approved by him February 8, 1890.

3. *From Broadway, Brooklyn, E. D., to the bridge pier adjacent to Fulton Ferry.*—The harbor lines on this front are those recommended by the New York Harbor Commission January, 1857, and enacted by chapter 763, act of the legislature of the State of New York, passed April 17, 1857.

The report of the commission describes the lines as follows:

"That the line of bulkhead in front of the Gobb Dock be the curve of 18 feet depth of water as laid down on map No. 1, East River, and that the exterior line in front thereof extend out 300 feet.

"That the exterior line be a line drawn from the northeast wharf of Fulton Ferry to the northwest corner, and thence to the northeast corner of Marston and Powers' coal depot, thence to the extremity of the long wharf, known as Wetmore's Dock, at the foot of Adams street, thence to the wharf at the gas-works, at the foot of Hudson avenue, and thence, in a curved direction, toward the Navy-Yard wall."

The bulkhead line on this front, which was adhered to by the New York Harbor Commission of 1857, as enacted by chapter 484, act of the legislature of the State of New York, passed May 25, 1836, is as follows:

SECTION 1 authorizes Henry Patchen and others, their heirs and assigns, to erect, construct, and maintain one or more wharves, docks, bulkheads, and piers on the land under water in front of their lands in the city of Brooklyn, but not to extend into the East River beyond a line beginning at a point on a line in continuation of the northwesterly side of Partition street, distant 700 feet from the westerly corner of Partition and Ferris streets, and running thence northeasterly parallel with Ferris street 320 feet; thence northeasterly on a straight line until it intersects a line running from the northerly corner of Dikeman and Ferris streets to a point 845 feet from the westerly corner of Columbia and Butler (now Harrison) streets on a line in continuation of Butler street at a point distant from said northerly corner of Dikeman and Ferris streets 1,800 feet; thence in a straight line northeasterly to the aforesaid point, distant from the westerly corner of Columbia and Butler streets 845 feet;* and from thence in a straight line until it intersects a line in continua-

*The line as described preceding this point was amended by chapter 268, laws of 1841, see page 8.

tion of the southerly side of Atlantic street in a direction which, if continued, would strike a point distant northwesterly from the northerly corner of Hicks and Smith's Docks at the foot of Joralemon street 245 feet.

SEC. 2. Three disinterested persons shall be appointed by the governor commissioners for the purpose of locating and determining a suitable line in the East River in front of the city of Brooklyn, upon which a permanent line of bulkheads may hereafter be erected without injuring the navigation of the said river; and the said commissioners, or any two of them, shall determine and locate such line, extending from a point or continued line of the southerly side of Atlantic street to a point at or opposite to the dock next easterly from Jackson Street (now Hudson avenue) Ferry, and make and subscribe an accurate description of said line and file the same in the office of the clerk of the county of Kings; and the line so determined and located shall be and remain the permanent water-line of the said city of Brooklyn between the points above mentioned, and thereafter no bulkhead shall be extended from the upland in said city into the East River beyond such line without the previous authority of the legislature, under the penalty of $1,000, to be paid by any person offending in the premises, to be sued for and recovered by the district attorney of the county of Kings in the name and to the use of the people of this State.

* * * * * * *

The report of the commissioners appointed by the preceding act described the line as follows:

Beginning at a point established by the act above mentioned, at the southerly side of Atlantic street, and running thence in a direct line northeasterly until it shall intersect a line made by continuing the northerly line of Middagh street, at a distance of 210 feet from the westerly line of Furman street; thence in a direct line until it shall intersect a line made by continuing the southerly side of Plymouth street, at a distance of 50 feet from the most westerly end of the easterly pier, now in occupation of the Fulton Ferry Company; thence in a direct line until it shall intersect a line made by continuing the westerly side of Fisher street, at the distance of 273 feet from the southerly side of Plymouth street; thence in a direct line to the northernmost end of the dock next east from the Jackson Street (now Hudson Avenue) Ferry.

* * * * * * *

4. *From the bridge pier at Fulton Ferry to south pier at Hamilton Avenue Ferry.*—The pier-head line on this front was recommended by the special board in their report to the governor of the State of New York dated April 5, 1873, and was enacted by chapter 702, act of the legislature of the State of New York, passed June 10, 1873, which is described as follows:

Such pier line is to commence at a point in the prolongation toward the channel of the southwest face of the abutment of the New York Bridge on the Brooklyn side, 20 feet distant from the northwest corner of said abutment, and running in a gentle curve to Martin's upper pier; thence in a straight line to the extremity of Martin's middle pier; thence in a straight line to the extremity of Martin's lower pier; thence in a straight line to a point in the prolongation and the upper line of Prentice's (formerly called Ford's) Pier, near the foot of Grace court prolonged, and 50 feet beyond the outer end of said pier; thence in a straight line to a point in the prolongation of the upper line of Robinson's Pier, between the foot of Warren street and the foot of Congress street, 200 feet beyond the outer end of last-mentioned pier; thence in line straight to a point on the prolongation of the upper line of the lower pier of Hamilton Ferry Slip, and 50 feet beyond the outer end of said pier. Nothing in this section contained shall interfere with the length of the upper-spring pile-fender pier at Fulton Ferry, as defined by the pier line established by the act entitled "An act to establish bulkhead and pier-head lines for the port of New York," passed April 17, 1857.

* * * * * * *

The bulkhead-line on this front was adhered to by the New York Harbor Commission, January, 1857, said line being established by chapter 484, act of the legislature of the State of New York, passed May 25, 1836, and amended by chapter 268, laws of 1841 (see pages 4, 5, 6, and 8).

5. *From south pier at Hamilton Avenue Ferry to Red Hook. (Partition street.)*—The pier-head line on this front was recommended by the special board in their report to the governor of the State of New York, dated May 5, 1875, and was enacted by chapter 491, act of the legislature of the State of New York, passed June 6, 1884. (For copy of act see paragraph 7, page 13.)

The bulkhead line on this front was adhered to by the New York Harbor Commission, January, 1857, as established by chapter 268, act of the legislature of the State of New York, passed May 26, 1841, which is described as follows:

Beginning at a point on a line in continuation of the northwesterly side of Partition street, distant 800 feet from the westerly corner of Partition and Ferris streets, and running thence northeasterly parallel with Ferris street, 320 feet; thence northeasterly on a straight line until it intersects a point 845 feet from the westerly corner of Butler (now Harrison) and Columbia streets, on a line in continuation of said Butler (now Harrison) street.

* * * * * * *

6. *From Partition street, Red Hook, to Hamilton avenue at Gowanus Canal (including Erie Basin).*—(*a*) From Partition street to the west side of Otsego street, and from the westerly side of Court street prolonged to Hamilton avenue, the bulkhead line on this front was recommended by the New York Harbor Commission of 1857 and enacted by chapter 763, act of the legislature of the State of New York, passed April 17, 1857.

(*b*) From the westerly side of Ferris street (Red Hook), prolonged running southerly to the entrance of Erie Basin, the sea-wall line was enacted by chapter 481, act of the legislature of the State of New York, passed April 24, 1862, and is described as follows:

The outer sea-wall line of Basin No. 1, of Gowanus Bay Basin, shall be altered as follows: The said outer line shall begin at the point of its commencement, as now established, namely: At a point in the line of the westerly side of Ferris street, as extended southerly 554 feet from the westerly side of Coast Wharf; running thence in a straight line to a point in the middle line of Van Brunt street, as extended southerly 1,155 feet from the southerly side of Reid street; running thence in a straight line to a point 100 feet westerly from the sea-wall line, as heretofore established, which point is 1,061 feet distant from and perpendicular to the westerly side of Otsego street as extended southerly at a point distant 1,719 feet from the southerly side of Cuba street; and running thence 606 feet and 6 inches in an arc, which arc has a radius of 696 feet, the center of said arc being at a point 453 feet distant from and perpendicular to the westerly side of Otsego street as extended southerly at a point 1,487 feet distant from the southerly side of Cuba street to a point in the said sea-wall line as now established. (From Van Brunt street south to the south angle of Erie Basin, the line was re-established by chapter 398, act of the legislature of the State of New York, passed May 20, 1875.) (For act see below, this page.)

* * * * * * *

(*c*) From the westerly side of Otsego street along the interior sea-wall of Erie Basin, through the entrance establishing the wing-wall at the entrance of the basin, thence along the interior sea-wall of the basin, thence along the proposed basins at Hicks and Henry streets to the westerly side of Court street prolonged the sea-wall, pier and bulkhead line was recommended by the special board in their report to the governor of the State of New York, dated May 5, 1875, and was enacted by chapter 398, act of the legislature of the State of New York, passed May 20, 1875, which is described as follows:

The pier, bulkhead, and other lines adjacent to the shores on the Brooklyn side of the port of New York, extending from a point on the easterly side of Court street, distant 500 feet southerly from the intersection of the said easterly side of Court street with the southerly side of Bryant street, to the entrance to Erie Basin, as at present by law established, are hereby altered, declared, and established as follows, that is to say: Such line shall commence at the point first above described, running thence westerly parallel with Bryant street and 500 feet therefrom 380 feet; thence southerly and at right angles to the last-mentioned line and parallel with Clinton street 393 feet to the exterior sea-wall line as at present established; thence along the said exterior sea-wall line 687 feet 2 inches to a point in a line parallel with Clinton street and distant 223 feet westerly from the westerly side of Clinton street; thence northerly from said point along the said line 2,361 feet to the southerly side of Bay street; thence westerly along the said southerly side of Bay street, 200 feet; thence southerly along a line drawn at right angles to said southerly side of Bay street 2,522 feet to the said exterior sea-wall line; thence southwesterly along the said exterior sea-wall line 565 feet 7 inches to a point in a line drawn at right angles to the southerly side of Bay street; thence northerly along said last-mentioned line 2,851 feet to said southerly side of Bay street; thence westerly along said southerly side of Bay street 200 feet; thence southerly on a line drawn at right angles to said southerly side of Bay street 2,980 feet to the said exterior sea-wall line; thence westerly, northwesterly, and northerly along said exterior sea-wall line to a point therein distant 75 feet southerly from the northerly end of said exterior sea-wall line as now established; thence westerly 125 feet; thence northerly on a line parallel with said exterior sea-wall line 30 feet; thence easterly to the northerly end of said sea-wall line as now established; thence southeasterly along the southern boundary-line of the entrance to Erie Basin as now established; thence southerly, southeasterly, and easterly along the interior boundary-line of the sea-wall of the Erie Basin as at present established, and a continuation thereof easterly to a point in a line at right angles to Halleck street and distant 2,440 feet therefrom; thence

from said point northerly along said line to the southerly side of Halleck street at a point distant 463 feet easterly from the easterly side of Otsego street; thence westerly along said southerly side of Halleck street 200 feet; thence southerly on a line at right angles to Halleis* street and parallel with Otsego street 1,000 feet to the bulkhead line as at present by law established; thence westerly along said bulkhead line to the westerly line of Otsego street.

* * * * * * *

7. *From Hamilton Avenue at Gowanus Canal to Bay Ridge avenue at Owls Head.*—The pier-head and bulkhead line on part of this front were recommended by the special board in their report to the governor of the State of New York, dated May 5, 1875, and enacted by chapter 491, act of the legislature of the State of New York, passed June 6, 1884, which is as follows:

The map filed in the office of the Secretary of State on the 4th day of March 1884, entitled "chart of pier and bulkhead lines of Gowanus Bay, New York Harbor as recommended by the special board of 1875," and certified by John Newton, Colonel of Engineers, Brevet Major-General, to be a full, true and correct copy of a map made by the commissioners appointed under concurrent resolutions relative to the pier and bulkhead lines in the harbor of New York, passed in Senate February 17, 1872, and in assembly April 6, 1872, and presented by the said commissioners to the governor, pursuant to section 3 of chapter 702 of the session laws of 1873, recommending certain pier and bulkhead lines in Gowanus Bay, and the copy of the report of said commissioners certified by said John Newton, Colonel of Engineers, to be a full and correct copy of the original report presented to the governor, together with said map, shall be held in all courts and before all tribunals to be sufficient evidence of the contents and effect of the original map and report made by said commissioners, and shall be of the same force and effect as said original map and report, and all grants of land under water within or to the exterior boundary line appearing upon said map and report made by the State, or hereby made to extend by the same course and direction to such exterior boundary line and are hereby ratified and confirmed as thus extending to the grantees thereof and their assigns in fee-simple.

* * * * * * *

The bulkhead line on part of this front, from Hamilton avenue to Twenty-fourth street, and from Forty-ninth street to Bay Ridge avenue, were recommended by the New York Harbor Commission of 1857 and enacted by chapter 763, act of the legislature of the State of New York, passed April 17, 1857.

8. *From Bay Ridge avenue, at Owl's Head, to the northern boundary of the Government land at Fort Hamilton.*—The pier-head line along this front has been enacted only in part. From Bay Ridge avenue to Eighty-ninth street the pier-head line was recommended by the special board in their report to the governor of the State of New York May 5, 1875, and has not been established by any act of legislature. From Eighty-ninth street to the boundary line the line was recommended by the New York Harbor Commission of 1857 and enacted by chapter 763, act of the legislature of the State of New York, passed April 17, 1857.

The bulkhead line on this front was recommended by the New York Harbor Commission of 1857 and enacted by chapter 763, act of the legislature of the State of New York, passed April 17, 1857.

Respectfully submitted.

HENRY L. ABBOT,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.,
President of the Board.

WM. P. CRAIGHILL,
Colonel of Engineers.

C. B. COMSTOCK,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.

D. C. HOUSTON,
Colonel of Engineers.

G. L. GILLESPIE,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

* Act in error; correct reading of the street is "Halleck."

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
March 3, 1890.

Respectfully submitted to the Secretary of War.

The Board of Engineers for Harbor Lines of New York Harbor reports that at a meeting held January 23, 1890, the following resolution was adopted referring to proposed harbor lines on the easterly shore of East River, Buttermilk Channel, Upper New York Bay, and both shores of Gowanus Bay, New York, extending from the foot of Broadway, Brooklyn, E. D., to the northern boundary of the Government land at Fort Hamilton, Long Island:

Resolved, That the present legal pier and bulkhead lines between Broadway Ferry, Brooklyn, and the northern boundary of the Government land at Fort Hamilton be recommended for approval, except that the pier and bulkhead lines exterior to the Erie Basin be made coincident with the present bulkhead line there: * * *
Provided, however, That between Seventeenth street, on the south shore of Gowanus Creek, and Fort Hamilton, the piers between the limits of the pier and bulkhead lines may be filled with solid materials when an equal tidal prism is provided in compensation therefor behind the authorized bulkhead line and adjacent to said piers.

In the report of the Board, dated January 27, 1890, recommending for the approval of the Secretary of War "the legal pierhead and bulkhead lines on the easterly shore of East River, from Broadway Ferry, Brooklyn, to the eastern end of the pier line at Ravenswood, established by the laws of the State of New York, chapter 536, June 15, 1889," which lines were approved by the Secretary of War February 8, 1890, it is stated that the Board had "considered and adopted for recommendation a greater length of shore line than embraced between the limits mentioned in the resolution contained in the report of January 27."

The Board now presents additional maps, covering the space not included in the report of January 27, and completing the harbor lines on the east side of the East River, and of the harbor of New York from Lawrence Point, opposite Port Morris, to the Narrows.

The lines submitted for approval are fully described herein and are delineated on the accompanying tracings, and are as follows:

1. From Lawrence Point, opposite Port Morris, to eastern end of pier line at Ravenswood, Long Island.
2. From Ravenswood, Long Island, to Broadway Ferry, Brooklyn, E. D.
3. From Broadway, Brooklyn, E. D., to the bridge pier adjacent to Fulton Ferry.
4. From the bridge pier at Fulton Ferry to south pier at Hamilton Avenue Ferry.
5. From South Pier, at Hamilton Avenue Ferry, to Red Hook (Partition street).
6. From Partition street, Red Hook, to Hamilton avenue, at Gowanus Canal (including Erie Basin).
7. From Hamilton avenue, at Gowanus Canal, to Bay Ridge avenue, at Owl's Head.
8. From Bay Ridge avenue, at Owl's Head, to the northern boundary of the Government land at Fort Hamilton.

It is recommended that the lines proposed by the Board be approved, and that the Secretary place his approval both upon the report and the tracings submitted.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

from said point northerly along said line to the southerly side of Halleck street at a point distant 463 feet easterly from the easterly side of Otsego street; thence westerly along said southerly side of Halleck street 200 feet; thence southerly on a line at right angles to Halleis* street and parallel with Otsego street 1,000 feet to the bulkhead line as at present by law established; thence westerly along said bulkhead line to the westerly line of Otsego street.

* * * * * * *

7. *From Hamilton Avenue at Gowanus Canal to Bay Ridge avenue at Owls Head.*—The pier-head and bulkhead line on part of this front were recommended by the special board in their report to the governor of the State of New York, dated May 5, 1875, and enacted by chapter 491, act of the legislature of the State of New York, passed June 6, 1884, which is as follows:

The map filed in the office of the Secretary of State on the 4th day of March 1884, entitled "chart of pier and bulkhead lines of Gowanus Bay, New York Harbor as recommended by the special board of 1875," and certified by John Newton, Colonel of Engineers, Brevet Major-General, to be a full, true and correct copy of a map made by the commissioners appointed under concurrent resolutions relative to the pier and bulkhead lines in the harbor of New York, passed in Senate February 17, 1872, and in assembly April 6, 1872, and presented by the said commissioners to the governor, pursuant to section 3 of chapter 702 of the session laws of 1873, recommending certain pier and bulkhead lines in Gowanus Bay, and the copy of the report of said commissioners certified by said John Newton, Colonel of Engineers, to be a full and correct copy of the original report presented to the governor, together with said map, shall be held in all courts and before all tribunals to be sufficient evidence of the contents and effect of the original map and report made by said commissioners, and shall be of the same force and effect as said original map and report, and all grants of land under water within or to the exterior boundary line appearing upon saidmap and report made by the State, or hereby made to extend by the same course and direction to such exterior boundary line and are hereby ratified and confirmed as thus extending to the grantees thereof and their assigns in fee-simple.

* * * * * * *

The bulkhead line on part of this front, from Hamilton avenue to Twenty-fourth street, and from Forty-ninth street to Bay Ridge avenue, were recommended by the New York Harbor Commission of 1857 and enacted by chapter 763, act of the legislature of the State of New York, passed April 17, 1857.

8. *From Bay Ridge avenue, at Owl's Head, to the northern boundary of the Government land at Fort Hamilton.*—The pier-head line along this front has been enacted only in part. From Bay Ridge avenue to Eighty-ninth street the pier-head line was recommended by the special board in their report to the governor of the State of New York May 5, 1875, and has not been established by any act of legislature. From Eighty-ninth street to the boundary line the line was recommended by the New York Harbor Commission of 1857 and enacted by chapter 763, act of the legislature of the State of New York, passed April 17, 1857.

The bulkhead line on this front was recommended by the New York Harbor Commission of 1857 and enacted by chapter 763, act of the legislature of the State of New York, passed April 17, 1857.

Respectfully submitted.

HENRY L. ABBOT,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.,
President of the Board.

WM. P. CRAIGHILL,
Colonel of Engineers.

C. B. COMSTOCK,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.

D. C. HOUSTON,
Colonel of Engineers.

G. L. GILLESPIE,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

---

* Act in error; correct reading of the street is "Halleck."

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
March 3, 1890.

Respectfully submitted to the Secretary of War.

The Board of Engineers for Harbor Lines of New York Harbor reports that at a meeting held January 23, 1890, the following resolution was adopted referring to proposed harbor lines on the easterly shore of East River, Buttermilk Channel, Upper New York Bay, and both shores of Gowanus Bay, New York, extending from the foot of Broadway, Brooklyn, E. D., to the northern boundary of the Government land at Fort Hamilton, Long Island:

Resolved, That the present legal pier and bulkhead lines between Broadway Ferry, Brooklyn, and the northern boundary of the Government land at Fort Hamilton be recommended for approval, except that the pier and bulkhead lines exterior to the Erie Basin be made coincident with the present bulkhead line there: * * *
Provided, however, That between Seventeenth street, on the south shore of Gowanus Creek, and Fort Hamilton, the piers between the limits of the pier and bulkhead lines may be filled with solid materials when an equal tidal prism is provided in compensation therefor behind the authorized bulkhead line and adjacent to said piers.

In the report of the Board, dated January 27, 1890, recommending for the approval of the Secretary of War "the legal pierhead and bulkhead lines on the easterly shore of East River, from Broadway Ferry, Brooklyn, to the eastern end of the pier line at Ravenswood, established by the laws of the State of New York, chapter 536, June 15, 1889," which lines were approved by the Secretary of War February 8, 1890, it is stated that the Board had "considered and adopted for recommendation a greater length of shore line than embraced between the limits mentioned in the resolution contained in the report of January 27."

The Board now presents additional maps, covering the space not included in the report of January 27, and completing the harbor lines on the east side of the East River, and of the harbor of New York from Lawrence Point, opposite Port Morris, to the Narrows.

The lines submitted for approval are fully described herein and are delineated on the accompanying tracings, and are as follows:

1. From Lawrence Point, opposite Port Morris, to eastern end of pier line at Ravenswood, Long Island.
2. From Ravenswood, Long Island, to Broadway Ferry, Brooklyn, E. D.
3. From Broadway, Brooklyn, E. D., to the bridge pier adjacent to Fulton Ferry.
4. From the bridge pier at Fulton Ferry to south pier at Hamilton Avenue Ferry.
5. From South Pier, at Hamilton Avenue Ferry, to Red Hook (Partition street).
6. From Partition street, Red Hook, to Hamilton avenue, at Gowanus Canal (including Erie Basin).
7. From Hamilton avenue, at Gowanus Canal, to Bay Ridge avenue, at Owl's Head.
8. From Bay Ridge avenue, at Owl's Head, to the northern boundary of the Government land at Fort Hamilton.

It is recommended that the lines proposed by the Board be approved, and that the Secretary place his approval both upon the report and the tracings submitted.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Second indorsement.]

WAR DEPARTMENT, *March* 4, 1890.

Approved.

REDFIELD PROCTOR,
Secretary of War.

---

f. HARBOR LINES FOR WEST BANK OF HUDSON RIVER, ALONG JERSEY CITY FRONT, FROM WEEHAWKEN COVE TO COMMUNIPAW FERRY.

HARBOR LINE BOARD,
New York City, February 18, 1890.

GENERAL: The Board of Engineers for Harbor Lines of New York Harbor, constituted by Special Orders No. 49, Headquarters Corps of Engineers, October 5, 1888, has the honor to state that at its meeting held in this city January 23, 1890, the following resolution was adopted:

Resolved, That the present legal harbor lines between Guttenberg and Communipaw Ferry of the Central Railroad of New Jersey be recommended to the Secretary of War for adoption, and that Colonel Gillespie be requested to prepare a map and definitions for the same at as early a date as practicable.

The shore-line embraced within this report extends along the right bank of the Hudson River at Jersey City, N. J., from Communipaw Ferry of the Central Railroad of New Jersey to and beyond the docks of the New York, Lake Erie and Western Improvement Company, on the north side of Weehawken Cove, New Jersey, and the harbor lines which the Board submits to the Secretary of War for approval and adoption were established by the Riparian Commission of New Jersey in 1865, 1872, 1875, and 1882, and are now the legal lines. Castle Point projects so far beyond the general shore-line that the Board is of the opinion that the harbor lines should have been drawn tangent thereto, but as such a modification would interfere with the vested rights duly acquired under the laws of the State, and of great value, and would involve the removal of the only public pier in Hoboken, the Board prefers to recommend the lines as now fixed by law.

The Board has been urged to extend the pier-head line outward 200 feet approximately along the whole front. The increased length of modern ocean steamers demanding increased maneuvering space for entering and leaving slips, the crowded condition of the channel in this vicinity, and the extensive encroachments by piers, wharves, and shore fillings on this front since 1804 have decided the Board that no further extension of piers towards deep water is admissible.

The harbor-lines recommended in this report for the approval and adoption of the Secretary of War are fully described in a separate paper forming an inclosure to this report.

Respectfully submitted.

HENRY L. ABBOT,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.
WM. P. CRAIGHILL,
Colonel of Engineers.
C. B. COMSTOCK,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.
D. C. HOUSTON,
Colonel of Engineers.
G. L. GILLESPIE,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
March 3, 1890.

Respectfully submitted to the Secretary of War.

The Board of Engineers for Harbor-Lines of New York Harbor states that at its meeting held January 23, 1890, the following resolution was adopted:

Resolved, That the present legal harbor-lines between Guttenberg and Communipaw Ferry of the Central Railroad of New Jersey be recommended to the Secretary of War for adoption.

The Board accordingly submits for approval pier-head and bulkhead lines described in the within inclosure and delineated on the accompanying chart for the west bank of the Hudson River extending along the Jersey City front from Communipaw Ferry of the Central Railroad of New Jersey to and beyond the docks of the New York, Lake Erie and Western Improvement Company on the north side of Weehawken Cove, New Jersey.

The Board states that these lines were established by the Riparian Commission of New Jersey in 1865, 1872, 1875, and 1882, and are now the legal lines.

It is recommended that the lines proposed by the Board be approved and that the Secretary place his approval both upon the report and the tracing submitted.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Second indorsement.]

WAR DEPARTMENT, *March* 4, 1890.

Approved.

REDFIELD PROCTOR, *Secretary of War.*

DESCRIPTION OF HARBOR-LINES FOR THE WEST BANK OF THE HUDSON RIVER, EXTENDING ALONG THE JERSEY CITY FRONT FROM COMMUNIPAW FERRY OF THE CENTRAL RAILROAD OF NEW JERSEY TO AND BEYOND THE DOCKS OF THE NEW YORK, LAKE ERIE AND WESTERN IMPROVEMENT COMPANY ON THE NORTH SIDE OF WEEHAWKEN COVE, NEW JERSEY, WHICH ARE RECOMMENDED TO THE SECRETARY OF WAR FOR APPROVAL AND ADOPTION BY THE BOARD OF ENGINEERS FOR HARBOR-LINES FOR NEW YORK HARBOR CONSTITUTED BY SPECIAL ORDER 49, HEADQUARTERS CORPS OF ENGINEERS, OCTOBER 5, 1888, IN A REPORT DATED FEBRUARY 18, 1890.

Pier-head line.—The pier-head line begins at a point in the south side of the south pier of the Central Railroad of New Jersey at Communipaw, 700 feet from the east side of Hudson street prolonged southerly; thence running northerly to a point in the center line prolonged east of the pier on the north side of Morris Canal basin, 900 feet from east side of Hudson street prolonged south; thence running northerly in a straight line to a point opposite Ferry street, Hoboken, 1,212 feet east of the east side of Hudson street and 200 feet north from the south side of Ferry street; thence running in a straight line to a point in a line 300 feet north of the north side of Seventh street and 1,423 feet east of the east side of Hudson street; thence running on a curve with a radius of 1,200 feet to a point in a line 275 feet south of the south side of Ninth street and 1,423 feet east of the east side of Hudson street; thence running in a straight line to a point in the north side of Seventeenth street prolonged 2,176 feet 1 inch east of the east side of Meadow street; thence running in the aforesaid straight line about 665 feet to a point at which the line deflects to the eastward as shown upon the map.

Bulkhead line.—The bulkhead line begins at the docks of the Central Railroad of New Jersey, at a point in a line 300 feet east of and parallel to the east side of Hudson street, prolonged southerly. From the south face of the pier on the north side of Morris Canal Basin, the bulkhead line begins at a point 400 feet east of the east side of Hudson street and runs in a straight line to a point in the north side of Thirteenth

street, prolonged easterly 2,190 feet from the east side of Provost street, Jersey City; thence in a straight line to a point in a line 65 feet south of the south line of Second street, Hoboken, and 767 feet from the east side of Hudson street; thence in a straight line to a point in a line 300 feet north of the north side of Seventh street and 1,218 feet east of the east side of Hudson street; thence on a curve with a radius of 1,000 feet to a point in a line 275 feet south of the south side of Ninth street, and 1,218 feet east of the east side of Hudson street; thence in a straight line to a point in the north side of Thirteenth street, prolonged east, and 1,915 feet 11 inches from the east side of Meadow street; thence in a straight line to a point in the north side of Seventeenth street prolonged east and 1,775 feet from the east side of Meadow street; thence along the aforesaid line about 812 feet to a point at which the line deflects to the eastward as shown upon the map.

---

g. HARBOR-LINES FOR EAST, NORTH, AND WEST SHORES OF NEWARK BAY, NEW JERSEY.

HARBOR-LINE BOARD,
New York City, March 19, 1890.

GENERAL: The Harbor-Line Board for New York Harbor and its adjacent waters, constituted by Special Orders No. 49, Headquarters, Corps of Engineers, October 5, 1888, to comply with section 12 of the river and harbor act of August 11, 1888, has the honor to recommend for the approval of the Secretary of War harbor-lines for the east, north, and west shores of Newark Bay, New Jersey.

The lines recommended for the east shore are the existing legal lines established by the Riparian Commission of New Jersey in 1877. The Riparian Commission for New Jersey has never established complete lines for the north and west shores of the bay, and those now recommended by the Board, without conflicting with legal lines, are so placed as to protect in the best possible way the important tidal basin which the bay affords. On the north shore the lines follow rigidly the natural shore of the point of land separating the outlets of the Hackensack and Passaic rivers. On the west shore the recommended lines follow the natural shore of the west bank of the Passaic River from Newark and New York Railroad Bridge to and along the channel-face of the dike built by the United States in 1880–1882 to improve the navigable channel leading from the bay into the Passaic River to connect with the line marking the present southern limit of the filling made by the Waverly and New York Bay Railroad Company on the west side of the dike, thence along the south side of the said southern limit of filling to the natural shore-line on the west side of the bay, and thence to connect with the lines at Elizabethport, adopted by the Secretary of War March 4, 1890.

The lines which the Board recommends for the approval of the Secretary of War are more particularly described in a separate paper, which, with an illustrative chart, forms an inclosure to this report.

Respectfully submitted.

HENRY L. ABBOT,
Colonel of Engineers.
Bvt. Brig. Gen., U. S. A.
WM. P. CRAIGHILL,
Colonel of Engineers.
C. B. COMSTOCK,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.
G. L. GILLESPIE,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
March 26, 1890.

Respectfully submitted to the Secretary of War.

The Harbor-Line Board for New York Harbor and its adjacent waters, constituted by Special Orders, No. 49, Headquarters Corps of Engineers, October 5, 1888, recommends for the approval of the Secretary of War the following harbor-lines described in the within report and delineated upon the accompanying chart:

1. Pier-head and bulkhead lines for the east shore of Newark Bay, New Jersey, extending from Bergen Point to the New York and Newark Railroad Bridge across the Hackensack River.

2. Pier-head and bulkhead lines for the north shore of Newark Bay, New Jersey, extending from the New York and Newark Railroad Bridge across the Hackensack River to the New York and Newark Railroad Bridge across the Passaic River.

3. Pier-head and bulkhead lines for the west shore of Newark Bay, New Jersey, extending from the New York and Newark railroad bridge across the Passaic River to Elizabethport.

It is recommended that the lines selected be approved and that the Secretary place his approval both upon the report and the tracing submitted.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Second indorsement.]

WAR DEPARTMENT, *March* 27, 1890.

Approved.

REDFIELD PROCTOR,
Secretary of War.

DESCRIPTION OF THE HARBOR-LINES FOR THE EAST, NORTH, AND WEST SHORES OF NEWARK BAY, NEW JERSEY, WHICH ARE RECOMMENDED FOR THE APPROVAL OF THE SECRETARY OF WVR BY THE HARBOR-LINE BOARD FOR NEW YORK HARBOR AND ITS ADJACENT WATERS, MARCH 18, 1890, TO COMPLY WITH SECTION 12 OF THE RIVER AND HARBOR ACT OF AUGUST 11, 1888.

1. *Pier-head and bulkhead lines for the east shore of Newark Bay, extending from Bergen Point to the New York and Newark Railroad Bridge across the Hackensack River.*—The pier-head line is described as follows: Beginning at the terminal point of the pier-head line approved by the Secretary of War January 4, 1890, said point being in the south side of First street prolonged westerly and 1,800 feet from the east side of Avenue B, the pier-head line runs thence northeasterly in a straight line 1,800 feet west of and parallel to the east side of Avenue B to the north side of Fifty-sixth street prolonged westerly; thence northerly on a curve with a radius of 4,000 feet to a point at a distance of about 4,550 feet; thence running northerly on a tangent to a point at a distance of about 1,230 feet; thence northeasterly on a curve with a radius of 650 feet to a point at a distance of 1,150 feet; thence easterly on a curve with a radius of 4,725 feet to a point on the New York and Newark Railroad Bridge across the Hackensack River, 750 feet, approximately, west of east abutment of same, said point of intersection being about 1,060 feet from the center of the draw of the bridge.

The bulkhead line is described as follows: Beginning at the terminal point of the bulkhead line approved by the Secretary of War January 4, 1890, said point being 200 feet east of the pier-head line in the south side of First street, prolonged westerly, and 1,600 feet from the east side of Avenue B, the bulkhead line runs northeasterly in a straight line 200 feet east of andp arallel to the pier-head line to the north side of Fifty-sixth street prolonged westerly; thence northerly 200 feet east of and

parallel to the pier-head line on a curve with a radius of 4,200 feet to a point at a distance of about 4,800 feet; thence running northerly 200 feet east of and parallel to the pier-head line on a tangent to a point at a distance of about 1,340 feet; thence northeasterly on a curve with a radius of 450 feet to a point at a distance of about 775 feet and 75 feet east of the pier-head line; and thence easterly on a curve with a radius of 4,800 feet, 75 feet from and parallel to the pier-head line to a point on the New York and Newark Railroad Bridge across the Hackensack River.

2. *Pier-head and bulkhead lines for the north shore of Newark Bay, extending from the New York and Newark Railroad Bridge across Hackensack River to the New York and Newark Railroad Bridge across the Passaic River.*—The pier-head line is described as follows: Beginning at a point on the New York and Newark Railroad Bridge across the Hackensack River 270 feet east of high-water line, and about 1,400 feet west from the center of the draw, the pier-head line runs in a straight line southwesterly, following the general direction of the shore at about 200 feet distance therefrom to a point at a distance of 2,050 feet; thence westerly on a curve with a radius of 600 feet to a point at a distance of 930 feet; thence northerly on a curve with a radius of 2,100 feet to a point at a distance of 1,160 feet; and thence northerly in a straight line to a point on the New York and Newark Railroad Bridge across the Passaic River 190 feet west from high-water line, said point of intersection being about 730 feet east of the center of the draw.

The bulkhead line begins at a point on the New York and Newark Railroad Bridge across the Hackensack River 75 feet west of the pier-head line, and runs thence at a distance of 75 feet parallel to the pier-head line until it intersects the New York and Newark Railroad Bridge across the Passaic River.

3. *Pierhead and bulkhead lines for the west shore of Newark Bay, extending from the New York and Newark Railroad Bridge across the Passaic River to Elizabethport.*—The pier-head line is described as follows: Beginning at a point on the New York and Newark Railroad Bridge about 400 feet west of the center of the draw and 130 feet east of high-water line, the pier-head line runs southerly, following the general direction of the shore at about 100 feet therefrom until it meets the United States dike at a distance of about 1,140 feet from the shore end of the dike; thence along the channel face of the dike to the southerly line of piling of the Waverly and New York Railroad Company as at present built, said line of piling beginning at the dike 592 feet north of the south end of the dike; thence along said southerly line of piling as at present built a distance of 2,590 feet to a point 210 feet from the shore-line; thence southwesterly in a straight line 13,800 feet to a point marked A on the map, about 320 feet from the shore-line measured at right angles to the pier line; thence southwesterly in a straight line to the northeast corner of Singer's Dock, Elizabethport, N. J.; and thence running along the eastern face of Singer's Dock to the southwest corner, to connect with the north terminal point of the pier-head line at Elizabethport, N. J., approved by the Secretary of War March 4, 1890.

The bulkhead line is described as follows: Beginning at the west abutment of the New York and Newark Railroad Bridge across the Passaic River, the bulkhead line runs coincidentally with the pier-head line to the point in the southerly line of piling of the Waverly and New York Railroad Company, 210 feet east of the shore-line; thence along the south side of said line of piling until it meets the shore-line; thence southwesterly in a straight line 200 feet west from and parallel to the pier-head line to the point marked A on the map; thence deflects from the pier-head line and runs southwesterly in a straight line to the northern terminal point of the bulkhead line at Elizabethport, approved by the Secretary of War March 4, 1890.

---

h. HARBOR-LINES FOR WEST BANK OF NORTH RIVER FROM WEEHAWKEN COVE TO GUTTENBERG, NEW JERSEY; EAST BANK OF NORTH RIVER FROM WEST EIGHTIETH STREET TO THE BATTERY, NEW YORK CITY; THE BATTERY; AND NORTH AND WEST SHORES OF EAST RIVER FROM THE BATTERY TO EAST EIGHTY-FIRST STREET, NEW YORK CITY.

HARBOR-LINE BOARD,
New York City, April 15, 1890.

GENERAL: The Harbor-Line Board for New York Harbor and its adjacent waters, constituted by Special Orders, No. 49, Headquarters Corps of Engineers, October 5, 1888, to comply with section 12 of the river and harbor act of August 11, 1888, has the honor to recommend to

the Secretary of War for his approval and adoption the following harbor-lines for North and East rivers, New York Harbor:

1. North River, west bank, from Weehawken Cove to Guttenberg, N. J., in continuation northward of the lines for that bank approved by the Secretary of War March 4, 1890.

2. North River, east bank, from West Eightieth street, New York City, south to the Battery.

3. East River, from the Battery east and north to East Eighty-first street, New York City.

The lines which are herein recommended for adoption are the existing legal lines enacted by the States of New Jersey and New York, respectively, except the pier-head line between the Battery and West Twenty-third street, New York City, which the Board has deemed it best to push outwards for the better convenience of navigation, the maximum extension being at Canal street, where it is 155 feet, approximately. This extension will not only afford to the steam-ship companies much needed slip room for docking, loading, and unloading their large steamers, but will give wharf length sufficient to protect the steamers while lying in their slips against damage by collisions with passing craft, a protection which the longest steamers do not now have.

At West Fourteenth street, North River, the original width of the river has been materially impaired by artificial encroachments on both banks, the more to be regretted as Castle Point, a rocky headland on the opposite shore, formed originally a marked gorge in the river which should not have been made worse by artificial shore extensions.

From West Eleventh street north to West Seventeenth street, New York City, the existing legal pier-head and bulkhead lines coincide. The unfortunate extension of the bulkhead line to nearly the established limit for the pier-head line, to the southward, has had the effect of restricting very much the lengths of the piers, and, in consequence, of prohibiting the use of this front to all except small vessels.

The Board thinks that if wharf room is needed in this locality for longer vessels it should be gained only by excavations in rear of the bulkhead line, and not by extensions of piers into the river beyond the line now recommended.

The lines recommended to the Secretary of War for approval and adoption are described in detail in a separate paper which accompanies this report.

Respectfully submitted.

HENRY L. ABBOT,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.
WM. P. CRAIGHILL,
Colonel of Engineers.
C. B. COMSTOCK,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.
D. C. HOUSTON,
Colonel of Engineers.
G. L. GILLESPIE,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
April 24, 1890.

Respectfully submitted to the Secretary of War.

The Harbor-Line Board for New York Harbor and its adjacent waters, constituted by Special Orders, No. 49, Headquarters Corps of Engineers, October 5, 1888, recommends for approval the following harbor-lines for North and East rivers, New York Harbor:

1. West shore of North River from New York, Lake Erie and Western Docks and Improvement Company, east side of Weehawken Cove, New Jersey, to Guttenberg, N. J.
2. East shore of North River, from West Eighty-first street to the Battery, New York City.
3. Pier and bulkhead lines at the Battery.
4. North and west shores of the East River, from the Battery to East Eighty-first street, New York City.

The lines are described in detail in the inclosed paper and delineated upon the accompanying tracing.

It is recommended that the lines selected be approved, and that the Secretary place his approval both upon the report and upon the tracing submitted.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Second indorsement.]

WAR DEPARTMENT, *April* 25, 1890.

Approved.

REDFIELD PROCTOR,
Secretary of War.

DESCRIPTION OF HARBOR-LINES ON THE WEST SHORE OF THE NORTH RIVER FROM THE EAST SIDE OF WEEHAWKEN COVE, NEW JERSEY, NORTHERLY TO GUTTENBERG, NEW JERSEY; ON THE EAST SHORE OF NORTH RIVER FROM WEST EIGHTY-FIRST STREET, NEW YORK CITY, SOUTHERLY TO THE BATTERY, AND ON THE NORTH AND WEST SHORES OF THE EAST RIVER FROM THE BATTERY TO EAST EIGHTY-FIRST STREET, NEW YORK CITY, WHICH ARE RECOMMENDED TO THE SECRETARY OF WAR FOR APPROVAL AND ADOPTION, BY THE BOARD OF ENGINEERS FOR HARBOR-LINES OF NEW YORK HARBOR, CONSTITUTED BY SPECIAL ORDERS, NO. 49, HEADQUARTERS CORPS OF ENGINEERS, OCTOBER 5, 1888, IN A REPORT DATED APRIL 15, 1890.

1. *West shore of North River from New York, Lake Erie and Western Docks and Improvement Company, eastside of Weehawken Cove, New Jersey, to Guttenberg, New Jersey.*—The pier-head line was established by the Riparian Commission of New Jersey in 1865, and the bulkhead line, which is parallel with pier-head line, and 300 feet inside, was established by the same commission in 1875. There is no written description of the lines, but their location is fixed by offsets from permanent monuments inshore, which are indicated upon the map.

2. *East shore of North River from West Eighty-first street to the Battery, New York City—Bulkhead line.*—The bulkhead line begins at a point in the north side of West Eighty-first street prolonged westerly and 1,150 feet from the west side of Eleventh avenue, and runs thence in a straight line to a point in the south side of West Seventy-second street prolonged westerly 1,100 feet from the west side of Eleventh avenue; thence in a straight line to a point in the south side of West Seventieth street prolonged westerly 1,100 feet from the west side of Eleventh avenue; thence along the south side of West Seventieth street to a point 1,000 feet from the west side of Eleventh avenue; thence in a straight line to a point in the south side of West Sixty-fifth street, 1,000 feet from the west side of Eleventh avenue; thence along the south side of West

Sixty-fifth street to a point 1,100 feet from the west side of Eleventh avenue; thence in a straight line to a point in the south side of west Sixty-second street 1,100 feet from the west side of Eleventh avenue; thence in a straight line to a point in the north side of West Sixty-first street 1,090 feet from the west side of Eleventh avenue; thence along the north side of West Sixty-first street to a point 1050 feet from the west side of Eleventh avenue; thence in a straight line to the north side of West Twenty-ninth street at a distance of 250 feet from the east side of Twelfth avenue and parallel to it; thence in a straight line to the north side of West Seventeenth street at a distance of 250 feet from the east side of Thirteenth avenue and parallel to it; thence in a straight line to the north side of West Sixteenth street prolonged westerly 379 feet from the east side of Eleventh avenue; thence in a straight line to a point in the north side of West Fifteenth street prolonged westerly 321 feet from the east side of Eleventh avenue; thence in a straight line to a point in the north side of West Fourteenth street prolonged westerly 260 feet from the east side of Eleventh avenue; thence in a straight line to a point in the south side of West Fourteenth street prolonged westerly 275 feet from the east side of Thirteenth avenue; thence in a straight line to a point in the north side of Little Twelfth street prolonged westerly 277 feet from the east side of Thirteenth avenue; thence in a straight line to a point in the north side of Bloomfield street 252 feet from the east side of Thirteenth avenue; thence in a straight line to a point in the north side of Bethune street prolonged westerly 252 feet from the east side of Thirteenth avenue; thence in a straight line to a point in the south side of West Eleventh street prolonged westerly 258 feet from the east side of Thirteenth avenue; thence in a straight line to a point in the south side of new Pier 47, 560 feet from the east side of West street; thence in a straight line to a point in the south side of new Pier 46, 340 feet from the east side of West street; thence in a straight line to a point in the north side of new Pier 45, 270 feet from the east side of West street; thence in a straight line to a point in the north side of new Pier 44, 250 feet from the east side of West street; thence at a distance of 250 feet from and parallel to the east side of West street, in its several courses, to a point in a line drawn at a right angle to the east side of West street prolonged southerly and 365 feet south of the north side of Battery Place; thence easterly along the said line (drawn at a right angle 365 feet south of the north side of Battery Place) until it intersects the established pier and bulkhead line of the New York Harbor Commission of 1857.

Pier-head line.—The pier-head line begins at a point in the north side of West Eighty-first street prolonged westerly and 1,500 feet from the west side of Eleventh avenue; thence in a straight line to a point in the south side of West Seventy-second street prolonged westerly 1,500 feet from the west side of Eleventh avenue; thence in a straight line to a point in the north side of West Sixty-first street prolonged westerly 1,550 feet from the west side of Eleventh avenue; thence in a straight line to a point in the north side of West Thirtieth street prolonged westerly 1,550 feet from the west side of Eleventh avenue; thence in a straight line to a point in the north side of West Twenty-ninth street prolonged westerly 763 feet from the east side of Thirteenth avenue; thence in a straight line to a point in the north side of West Twenty-third street prolonged westerly 767 feet from the east side of Thirteenth avenue; thence in a straight line to a point in the center line of new Pier 45, foot of West Tenth street, prolonged westerly 630 feet from the bulkhead line (said point being 100 feet west of the extremity of the new pier); thence in a straight line to a point in the center line of new Pier 26, foot of Beach street, prolonged westerly 651 feet from the bulkhead line (said point being 100 feet west of the extremity of the new pier); thence in a straight line to a point in the southerly side of the new Pier 1, Battery Place, prolonged westerly 500 feet from the bulkhead line; thence in a straight line to southwest corner of Pier A, a little north of the southerly limit of the land grant of 1871.

3. *Pier and Bulkhead lines at the Battery.*—The pier-head and bulkhead lines are coincident from Battery Place to the Barge Office Slip, and are the same as recommended by the New York Harbor Commission and established by chapter 763, act of the legislature of the State of New York, passed April 17, 1857, and are coincident with the sea-wall line as at present built, except at the bulkhead in front of Castle Garden, which is outside of the established lines. At the Barge Office Slip the pier and bulkhead lines begin to diverge.

4. *North and west shores of the East River, from the Battery to East Eighty-first street, New York City—Bulkhead line.*—The bulkhead line begins in the sea-wall at the Barge Office Slip, and continues in a gentle curve to a point in the northerly face of the proposed new Pier 1, said point being in a line drawn at a right angle to the north side of South street, at the corner of Whitehall street, and 250 feet therefrom; thence runs along said line normal to South street to a point 200 feet from the north side of South street; thence continues parallel to the north side of South street and 200 feet therefrom to a point in the west side of Roosevelt street prolonged southerly; thence to a point in the west side of James Slip prolonged southerly and 250

feet from the north side of South street; thence to a point in the west side of Oliver street prolonged southerly 205 feet from the north side of South street; thence to a point in the east side of Catharine street 200 feet from the north side of South street; thence continues parallel to the north side of South street and 200 feet therefrom to a point in a line drawn at 280 feet from the west side of Montgomery street at a right angle to the north side of South street; thence to a point in a line drawn at 166 feet from the west side of Montgomery street at a right angle to the north side of South street, 233 feet therefrom; thence to a point in the east side of Montgomery street prolonged southerly 150 feet from the north side of South street; thence continues parallel to the north side of South street and 150 feet therefrom to a point in the west side of Corlears street, prolonged southerly; thence in a curve to a point in a line drawn at a right angle at 250 feet from the west side of Corlears street to the north side of South street, prolonged easterly 110 feet therefrom; (thence the bulkhead line is coincident with the pier-head line) and continues in a curve to a point in the north side of South street, prolonged easterly 460 feet from the west side of Corlears street; thence in a curve to a point in the north side of Front street prolonged easterly 632 feet from the west side of Corlears street; thence the bulkhead and pier-head lines begin to diverge, and the bulkhead line continues to a point in the north side of Water street prolonged easterly 680 feet from the west of Corlears street; thence to a point in the south side of Grand street prolonged easterly 197 feet from the west side of East street; thence to a point in the south side of Rivington street 275 feet from the east side of Tompkins street; thence to a point in a line drawn at 160 feet from the north side of Rivington street at a right angle to the west side of Tompkins street and 175 feet therefrom; thence to a point in the north side of Stanton street 175 feet from the west side of Tompkins street; thence to a point in a line drawn at 14.1 feet from the south side of East Houston street at a right angle to the west side of Tompkins street and 103 feet therefrom; thence to a point in the north side of East Eighth street 675 feet from the east side of Avenue D; thence along the north side of East Eighth street to a point in the east side of Tompkins street established by act of April 12, 1826; thence along said east side of Tompkins street to a point in the south side of East Seventeenth street; thence along the south side of East Seventeenth street to a point 375 feet from the east side of Avenue C; thence to a point in the north side of East Twenty-third street prolonged easterly 603.39 feet from the west side of Avenue A; thence along the north side of East Twenty-third Street to a point 322 feet from the west side of Avenue A; thence to a point in the south side of East Twenty-fourth street prolonged easterly 322 feet from the west side of Avenue A; thence to a point in the south side of East Twenty-sixth street prolonged easterly 735 feet from the east side of First avenue; thence to a point in the north side of East Twenty-eighth street prolonged easterly 540 feet from the east side of First avenue; thence to a point in the north side of East Thirty-fourth street 335 feet from the east side of First avenue; thence in a curve to a point in the south side of East Thirty-fifth street 323 feet from the east side of First avenue; thence in a curve to a point in the south side of East Thirty-sixth street 321 feet from the east side of First avenue; thence in a curve to a point in the south side of East Thirty-seventh street 325 feet from the east side of First avenue; thence in a curve to a point in the south side of East Thirty-eighth street 335 feet from the east side of First avenue; thence along the south side of East Thirty-eighth street to a point 444 feet from the east side of First avenue; thence the bulkhead and pier-head lines are coincident, and continue in a curve to a point in the south side of East Thirty-ninth street 458 feet from the east side of First avenue; thence to a point in the south side of East Forty-ninth street 605 feet from the east side of First avenue; thence to a point in the north side of East Forty-ninth street 608 feet from the east side of First avenue; thence to a point in the south side of East Fifty-first street 632 feet from the east side of First avenue; thence to a point in the south side of East Fifty-third street 705 feet from the east side of First avenue; thence in a curve to a point in the south side of East Fifty-fourth street 106 feet from the east side of Avenue A; thence in a curve to a point in the south side of East Fifty-fifth street 166 feet from the east side of Avenue A; thence to a point in the south side of East Fifty-eighth street 218 feet from the east side of Avenue A; thence to a point in the south side of East Fifty-ninth street 210 feet from the east side of Avenue A; thence to a point in the north side of East Fifty-ninth street 250 feet from the east side of Avenue A; thence the pier-head and bulkhead lines begin to diverge; the bulkhead line continues to a point in the center line of East Sixty-fourth street 500 feet from the east side of Avenue A, on the bulkhead line approved by the Secretary of War April 11, 1889; thence the bulkhead and pier-head lines are coincident and continue to a point in the north side of East Sixty-sixth street prolonged easterly 610.94 feet from the east side of Avenue A; thence to a point in the north side of East Seventy-fifth street 825 feet from the east side of Avenue A; thence to a point in the south side of East Seventy-seventh street 825 feet from the east side of Avenue A; thence to a point in the north side of East Eighty-first street 201 feet from the east side of Avenue B.

Pier-head line.—The pier-head line begins at the Barge Office Slip at a point in the sea-wall line as now built and runs in a curve to the extremity of the proposed new Pier 1, in the southerly prolongation of the east side of Whitehall street, 692 feet from the north side of South street, or 492 feet from the bulkhead line; thence continues from pier to pier to the south side of Grand street, as proposed by the department of docks and approved by the sinking fund commissioners April 27, 1871, at certain distances from the bulkhead line measured along the new piers. Only a few of these distances are given as far as Clinton street on the accompanying map. They are as follows:

Location.	South of the bulkhead line.	Location.	South of the bulkhead line.
At or near—	*Feet.*	At or near—	*Feet.*
Broad street	491	Roosevelt street	448
Coenties Slip	500	Oliver street	446
Gouverneur Lane	479	Catharine street	338
Pine street	473	Market Slip	361
Burling Slip	482	Rutgers Slip	350
Beekman street	483	Clinton street	348
Dover street	460		

Thence the pier-head line continues to the extremity of the east pier, at Jackson Square; thence to a point in the west side of Corlears street, prolonged southerly 185 feet from the north side of South street; thence to a point in the east side of Corlears street, prolonged southerly 171 feet from the north side of South street; thence in a curve to a point in a line drawn at 250 feet from the west side of Corlears street at a right angle to the north side of South street, prolonged easterly and 110 feet therefrom; thence the pier-head and bulkhead lines coincide to a point in the easterly prolongation of the north side of Front street 632 feet from the west side of Corlears street; thence the pier-head line begins to diverge from the bulkhead line and continues to a point in the north side of Water street, prolongede asterly 725 feet from the west side of Corlears street; thence to a point in the south side of Grand street, prolonged easterly 344 feet from the west side of East street; thence to a point in the south side of Rivington street, prolonged easterly 233 feet from the bulkhead line; thence to a point in the south side of Stanton street, prolonged easterly 350 feet from the bulkhead line; thence to a point in the south side of East Third street, prolonged easterly 391 feet from the bulkhead line; thence to a point in the south side of East Fourth street, prolonged easterly 448 feet from the bulkhead line; thence to a point in the south side of East Sixth street, prolonged easterly 470 feet from the bulkhead line; thence to a point in the south side of East Eighth street, prolonged easterly 503 feet from the bulkhead line; thence in a curve to a point in the south side of East Ninth street, prolonged easterly 238 feet from the west side of Tompkins street, established by act of April 12, 1826; thence in a curve to a point in the south side of East Tenth street, prolonged easterly 261 feet from the west side of Tompkins street, established by act of April 12, 1826; thence in a curve to a point in the south side of East Eleventh street, prolonged easterly 284 feet from the west side of Tompkins street, established by act of April 12, 1826; thence in a curve to a point in the south side of East Twelfth street, prolonged easterly 294 feet from the west side of Tompkins street, established by act of April 12, 1826; thence in a curve to a point in the south side of East Thirteenth street, prolonged easterly 297 feet from the west side of Tompkins street, established by act of April 12, 1826; thence in a curve to a point in the south side of East Fourteenth street, prolonged easterly 288 feet from the west side of Tompkins street, established by act of April 12, 1826; thence in a curve to a point in the south side of East Fifteenth street, prolonged easterly 413 feet from the west side of Tompkins street, established by act of April 12, 1826; thence in a curve to a point in the south side of East Sixteenth street, prolonged easterly 558 feet from the west side of Tompkins street, established by act of April 12, 1826; thence in a curve to a point in the south side of East Seventeenth street, prolonged easterly 690 feet from the west side of Tompkins street, established by act of April 12, 1826; thence to a point in the south side of East Eighteenth street, prolonged easterly 522 feet from the bulkhead line; thence to a point in the south side of East Nineteenth street, prolonged easterly 555 feet from the bulkhead line; thence to a point in the south side of East Twentieth street, prolonged easterly 580 feet from the bulkhead line; thence to a point in the south side of East Twenty-first street, prolonged easterly 600 feet from the bulkhead line; thence to a point in the south side of East Twenty-second street, prolonged easterly 625 feet from the bulkhead line; thence to a point in the south side of

East Twenty-third street, prolonged easterly 942.44 feet from the bulkhead line; thence to a point in the south side of East Twenty-fourth street, prolonged easterly 820 feet from the bulkhead line; thence to a point in the south side of East Twenty-fifth street, prolonged easterly 735 feet from the bulkhead line; thence to a point in the south side of East Twenty-sixth street, prolonged easterly 660 feet from the bulkhead line; thence to a point in the south side of East Twenty-seventh street, prolonged easterly 595 feet from the bulkhead line; thence to a point in the south side of East Twenty-eighth street, prolonged easterly 530 feet from the bulkhead line; thence to a point in the south side of East Twenty-ninth street, prolonged easterly 445 feet from the bulkhead line; thence to a point in the south side of East Thirtieth street, prolonged easterly 365 feet from the bulkhead line; thence to a point in the south side of East Thirty-first street, prolonged easterly 295 feet from the bulkhead line; thence to a point in the south side of East Thirty-second street, prolonged easterly 235 feet from the bulkhead line; thence to a point in the south side of East Thirty-third street, prolonged easterly 195 feet from the bulkhead line; thence to a point in the north side of East Thirty-fourth street, prolonged easterly 155 feet from the bulkhead line; thence in a curve to a point in the south side of East Thirty-fifth street, prolonged easterly 456 feet from the east side of First avenue; thence in a curve to a point in the south side of East Thirty-sixth street, prolonged easterly 440 feet from the east side of First avenue; thence in a curve to a point in the south side of East Thirty-seventh street, prolonged easterly 437 feet from the east side of First avenue; thence in a curve to a point in the south side of East Thirty-eighth street, prolonged easterly 444 feet from the east side of First avenue; thence the pier-head and bulkhead lines coincide to a point in the north side of East Fifty-ninth street 250 feet from the east side of Avenue A; thence the pier-head line follows the pier-head line approved by the Secretary of War April 11, 1889, to the center line of East Sixty-fourth street 500 feet from the east side of Avenue A; thence the pier-head and bulkhead lines coincide to the north side of East Eighty-first street, as before described.

---

i. HARBOR-LINES FOR RARITAN BAY AND RIVER, NEW JERSEY, NORTH SHORE FROM PERTH AMBOY TO CRAB ISLAND, AND SOUTH SHORE FROM CRAB ISLAND AROUND SOUTH AMBOY TO CHEESEQUAKES CREEK.

HARBOR-LINE BOARD,
New York City, May 21, 1890.

GENERAL: The Harbor-Line Board for New York Harbor and its adjacent waters, constituted by Special Orders No. 49, Headquarters Corps of Engineers, October 5, 1888, and Special Orders No. 11, Headquarters Corps of Engineers, January 30, 1889, to comply with section 12 of the river and harbor act of August 11, 1888, has the honor to recommend for approval and adoption the following harbor-lines for part of the Raritan Bay and Raritan River, New Jersey, beginning at Perth Amboy, N. J., and following the north shore of Raritan River to the head of Crab Island and thence along the south shore of the river around South Amboy to Cheesequakes Creek, New Jersey.

From Perth Amboy to Keasby's Dock, Raritan River, north shore, and from Cheesequakes Creek to the railroad bridge at South Amboy, south shore, the lines which are herein recommended for adoption are the existing legal lines which were enacted by the State of New Jersey in 1878 and 1879. The Board thinks the harbor-lines which were established in 1879 by the Riparian Commission of New Jersey, between Marshy Point, south shore of Raritan River and the railroad bridge at South Amboy, N. J., project too far from the adjacent shore, and has therefore drawn them in as shown upon the map.

No lines have been heretofore established on the Raritan River above Marshy Point on the south shore of Keasby's Dock on the north shore.

The lines herein recommended for approval and adoption for part of

Raritan River and Bay are described in detail in a separate paper, which accompanies this report.

Respectfully submitted.

HENRY L. ABBOT,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.
WM. P. CRAIGHILL,
Colonel of Engineers.
C. B. COMSTOCK,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.
D. C. HOUSTON,
Colonel of Engineers.
G. L. GILLESPIE,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
June 18, 1890.

Respectfully submitted to the Secretary of War.

The Harbor-Line Board for New York Harbor and its adjacent waters, constituted by Special Orders No. 49, Headquarters Corps of Engineers, October 5, 1888, and Special Orders No. 11, January 30, 1889, recommends for the approval of the Secretary of War the following harbor-lines for part of Raritan Bay and Raritan River, New Jersey, described in the within report and delineated upon the accompanying chart.

1. Pier and bulkhead lines, north shore from Lewis street, produced, Perth Amboy, westerly to Dike A, opposite Crab Island.

2. Pier and bulkhead lines, south shore from head of Crab Island, easterly around South Amboy to Cheesequakes Creek.

It is recommended that the lines selected be approved and that the Secretary place his approval both upon the report and the tracing submitted.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Second indorsement.]

WAR DEPARTMENT, *June* 19, 1890.

Approved.

REDFIELD PROCTOR,
Secretary of War.

DESCRIPTION OF HARBOR LINES FOR PART OF RARITAN BAY AND RARITAN RIVER, NEW JERSEY, EXTENDING ON THE NORTH SHORE FROM LEWIS STREET, PRODUCED, PERTH AMBOY, WESTERLY TO DIKE A, OPPOSITE CRAB ISLAND, AND ON THE SOUTH SHORE FROM THE HEAD OF CRAB ISLAND, EASTERLY AROUND SOUTH AMBOY, TO CHEESEQUAKES CREEK; WHICH ARE RECOMMENDED FOR APPROVAL AND ADOPTION BY THE BOARD OF ENGINEERS FOR HARBOR LINES OF NEW YORK HARBOR, CONSTITUTED BY SPECIAL ORDERS NO. 49, HEADQUARTERS CORPS OF ENGINEERS, OCTOBER 5, 1888, IN A REPORT DATED MAY 21, 1890.

North shore.—The pier-head line begins at the terminal point, opposite the foot of Lewis street, Perth Amboy, described in a report of the New York Harbor Line Board dated February 18, 1890, and approved by the Secretary of War March 4, 1890; thence

continues in a straight line to a point in a line drawn easterly 65 feet, from and at right angles to the easterly line of High street produced southerly 885 feet from its intersection with the southerly line of Lewis street; thence in a straight line to a point on the New York and Long Branch Railroad Bridge across the Raritan River, 250 feet from the high-water line, and 1,590 feet from the center of the draw; thence in a straight line to a point 1,290 feet from the center line of the New York and Long Branch Railroad Bridge, in a line drawn at right angles to said bridge at a distance of 850 feet from the high-water line and 1,260 feet from the center of the draw; thence in a curve tangent to the high-water line at Sandy Point and 20 feet beyond the end of Watson's Dock—which projects about 150 feet from the shore-line, to a point 1,800 feet west from the center line of the New York and Long Branch Railroad Bridge, in a line drawn at right angles to said bridge at a distance of 130 feet from the high-water line, and 1,980 feet from the center of the draw; thence in a straight line to the southwest corner of Spring's Dock, 270 feet distant from the high-water line; thence in a straight line to a point in the westerly side of Debeau and Fisher's Dock, prolonged southerly, 45 feet from end of dock and 260 feet from high-water line; thence in a straight line to a point 200 feet from face of dock, in a line drawn at right angles to said face at its southeast corner; the said dock is 390 feet east of the dock of the Raritan River Hollow Brick Company; thence in a straight line to the southeast corner of Keasby's Dock, 210 feet distant from the high-water line; thence in a straight line to the southeast corner of Crow's Dock, 210 feet distant from the high-water line; thence to the northeast corner of Dike 3; thence continues along the channel face of said Dike 3, leaving an opening of 260 feet wide opposite Acken's Dock, at the mouth of Red Root Creek, to a point 110 feet from the junction of said dike with the shore-line; thence continues on a curve, following the general configuration of the shore and at distances from the high-water line as shown on the accompanying map, to the easterly end of Earth Dike C; thence along the face of said Dike C to a point 120 feet from its junction with the shore-line; thence in a curve following the general configuration of the shore-line to the northeasterly end of Dike A; thence along the channel face of Dike A to its junction with the shore-line.

The bulkhead line begins at the terminal point opposite the foot of Lewis street, Perth Amboy, described in a report of the New York Harbor Line Board dated February 18, 1890, and approved by the Secretary of War, March 4, 1890; thence continues in a straight line parallel to and 200 feet distant from the pier-head line to a point in the west side of a dock at Ferry Point, which is 80 feet east of the easterly side of High street; thence in a straight line parallel to and 250 feet distant from the pier-head line to a point on the New York and Long Branch Railroad bridge, 270 feet from the high-water line and 1,840 feet from the center of the draw; thence in a curve gradually approaching the pier-head line until it coincides with the pier-head line around Sandy Point; thence it diverges from the pier-head line in a curve, which cuts Watson's Dock 15 feet from its outer end, to a point 200 feet from the pier-head line at the point in the latter which is above described as the end of the curve around Sandy Point; thence in straight lines parallel to and 200 feet distant from the pier-head line, in its several courses, to the southwesterly corner of Crow's Dock; thence in a straight line to the northeasterly end of Dike 3, from which point the bulkhead line coincides with the pier-head line as described before.

South shore.—The pier-head line begins at a point in the high-water line opposite the head of Crab Island, and continues in a curve following the general configuration of the shore and coincident with it to a point opposite the lower end of Crab Island; thence continues in a curve following the general configuration of the shore and tangent to the following-named docks at their extremities, the distances of which from the high-water line are also given approximately, viz:

	Feet.
Whitehead's Dock	265
Such's Dock	540
Smith's Dock	475
Kearney's Lower Dock	80

At Kearney's Upper Dock, which is about 110 feet long, the pier-head line is 135 feet north of the end of the dock; thence in a curve following the general configuration of the shore and at distances from the high-water line which are shown on the accompanying map, being tangent to the shore at Marshy Point and at two other points marked X and Y, respectively, between Marshy Point and the New York and Long Branch Railroad Bridge, to its intersection with the bridge at its southerly abutment, 1,910 feet from the center of the draw; thence along the easterly side of said railroad bridge 575 feet, to a point 1,335 feet from the center of the draw; thence along the easterly side of said railroad bridge 625 feet, to a point 710 feet from the center of the draw; thence in a straight line cutting the steam-boat dock 35 feet from its outer end and 1,310 feet from the high-water line, to the northeast corner of the dock

of the Camden and Amboy Railroad Company; thence in a curve with a radius of 685 feet and length of 345 feet; thence in a straight line, tangent to the Lehigh Pier, to a point in the northerly side of Henry street, South Amboy, produced, 2,945 feet from the easterly side of Broadway, said line being parallel to and 2,830 feet distant from the center line, between rails of the main track, as constructed April, 1890; thence in a curve to a point in the southerly side of Catharine street produced, 2,850 feet from its intersection with the easterly side of Broadway; thence to the northern extremity of the West Dike at Cheesequakes Creek, in a curve through points which are fixed by co-ordinates referred to the easterly side of Broadway, produced southerly, as the base line, and its intersections with the southerly side of Catharine street as the origin. The following table gives the abscissæ and the corresponding ordinates, viz:

Abscissæ.	Ordinates.
Feet.	*Feet.*
2,000	2,530
4,000	2,690
6,000	2,770
7,330	2,190

The bulkhead line coincides with the pier-head line along the shore south of Crab Island, and begins to diverge at a point opposite the lower end of that island.

The bulkhead line continues following the general configuration of the shore, and at distances from the high-water line and the pier-head line, as shown on the accompanying map, to the end of Kearney's Lower Dock. From this point it again coincides with the pier-head line, as before described, to a point on the easterly side of the New York and Long Branch Railroad Bridge, 575 feet from the center of the draw; thence continues in a straight line, cutting the steam-boat dock 700 feet from its outer end and 645 feet from the high-water line, along the face of the bulkhead joining the steam-boat dock and the dock of the Camden and Amboy Railroad Company to a point 40 feet beyond the southerly side of the latter dock, intersecting said southerly side of dock 340 feet from the inner end of slip; thence in a straight line to a point in the northerly side of Henry street, produced, South Amboy, 1,945 feet from the easterly side of Broadway, said line being parallel to and 1,830 feet distant from the center line between rails of main track as constructed in April, 1880; thence in a curve to a point in the southerly side of Catharine street, produced, 1,825 feet from the easterly side of Broadway; thence in a curve to the east side of north abutment of the New York and Long Branch Railroad Bridge across Cheesequakes Creek, through points fixed by co-ordinates referred to the easterly side of Broadway, produced, southerly as the base-line and its intersection with the southerly side of Catharine street as the origin. The following table gives the abscissæ and the corresponding ordinates, viz:

Abscissæ.	Ordinates.
Feet.	*Feet.*
2,000	1,570
4,000	1,770
6,000	1,870
8,000	850

---

j. HARBOR LINES FOR ELLIS ISLAND, NEW JERSEY.

HARBOR-LINE BOARD,
New York City, June 21, 1890.

GENERAL: The Harbor-Line Board for New York Harbor and its adjacent waters, constituted by Special Orders, No. 49, Headquarters Corps of Engineers, U. S. Army, October 5, 1888, to comply with section 12 of the river and harbor act of August 11, 1888, has the honor to recommend for approval and adoption, harbor lines for Ellis Island, New

Jersey, New York Harbor. The recommended lines which are delineated on the accompanying sketch are described as follows:

PIER-HEAD LINE.

The pier-head line begins at a point on the main wharf, marked "station" on the accompanying sketch, said station being a copper nail surrounded by four other nails driven in the floor of the wharf, and fixed by measurements from the east corner, viz: 2.4 feet from the corner measured westwardly along the face to another nail, driven in the top timber, inclosed between two cuts, and at a distance of 2.8 feet from the face of the wharf and at a right angle thereto; runs thence southeasterly in a straight line for a distance of 577 feet, making an angle of 17° 59″ with a line drawn from the "station" to Governor's Island flagstaff; thence southwesterly 800 feet in a straight line and at a right angle with the last direction; thence northwesterly in a straight line and at a right angle with the preceeding direction 800 feet; thence northeasterly in a straight line and at a right angle with the preceding direction 800 feet; thence southeasterly in a straight line 223 feet to the point and place of beginning.

BULKHEAD LINE.

The bulkhead line begins at a point in a line drawn through the "station" on the main wharf at a right angle to the pier-head line at that point and 100 feet therefrom; runs thence southeasterly in a straight line 577 feet parallel to the pier-head line and at a distance of 100 feet therefrom to connect with the southeast pier-head line; thence southwesterly along and coincident with said pier-head line a distance of 375 feet; thence northwesterly in a straight line and at a right angle with the preceding direction a distance of 800 feet to intersection with the northwesterly pier-head line; thence northeasterly along said pier-head line 375 feet; and thence southeasterly in a straight line and at a right angle with the foregoing pier and bulkhead line 223 feet to the point and place of beginning.

The term "pier-head" is applied in general to lines beyond which no pile structure shall extend, and the term "bulkhead" to lines beyond which no solid filling shall thereafter be permitted; but in the case considered the piers recommended on the southwest side of Ellis Island, designed to inclose a basin, may be constructed of cribs filled with stone or other solid material.

Respectfully submitted.

HENRY L. ABBOT,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.
WM. P. CRAIGHILL,
Colonel of Engineers.
C. B. COMSTOCK,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.
D. C. HOUSTON,
Colonel of Engineers.
G. L. GILLESPIE,
Lieutenant Colonel of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
July 8, 1890.

Respectfully submitted to the Secretary of War.

The Harbor-Line Board for New York Harbor and its adjacent waters, constituted by Special Orders, No. 49, Headquarters Corps of Engineers, October 5, 1888, recommends for the approval of the Secre-

tary of War harbor-lines for Ellis Island, New Jersey, New York Harbor, described in the within report and delineated upon the accompanying chart.

It is recommended that the lines selected be approved, and that the Secretary place his approval both upon the report and the tracing submitted.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Second indorsement.]

WAR DEPARTMENT,
July 9, 1890.

Approved.

REDFIELD PROCTOR,
Secretary of War.

---

k. PIER-HEAD LINE FOR WEST HALF OF SOUTH SHORE OF STATEN ISLAND, FROM SEGUINE'S POINT TO WARD'S POINT.

HARBOR-LINE BOARD,
New York City, July 15, 1890.

GENERAL: The Harbor-Line Board for New York Harbor and its adjacent waters, constituted by Special Orders, No. 49, Headquarters Corps of Engineers, October 5, 1888, and Special Orders, No. 11, Headquarters Corps of Engineers, January 30, 1889, to comply with section 12 of the river and harbor act of August 11, 1888, has the honor to recommend for adoption a pier-head line for the west half of the south shore of Staten Island, from the western terminus of the pier-head line established by the Secretary of War on that shore March 4, 1890, westward to Ward's Point, Staten Island, as delineated upon the accompanying map.

The Board submitted a report upon the south shore of Staten Island February 18, 1890, in which a bulkhead line was recommended along the whole water-front, extending from Fort Wadsworth to Ward's Point, and a separate pier-head line from Fort Wadsworth to a point 5,400 feet eastward of Seguine's Point. It was not deemed best at that time to recommend for the western half of the shore a pier-head line of equal extension to that projected for the eastern half, for the reason that the main ship-channel leading from Raritan Bay connects off Seguine's Point with the deep-water channel along the southwest side of Staten Island by a water-way running southeast from Seguine's Point, and a pier-head line placed at 1,500 feet from the shore-line would, if extended to and beyond Seguine's Point, cross such channel, to the injury of public interests.

Since the lines for the south shore of Staten Island were approved by the Secretary of War, March 4, 1890, and the charts distributed for the information of the public, the Board has been urged by many riparian owners between Seguine's Point and Ward's Point to recommend for this front a pier-head line, distinct from the bulkhead line, which shall fill the gap previously left in the pier-head line, and which shall enable riparian owners to extend piers from their front to deep water.

The Board has given two public hearings to the parties interested, and now has the honor to submit a pier-head line for the west half of

the south shore, distinct from the bulkhead line, which will, in its opinion, best subserve the purpose for which harbor-lines are established, thus completing the system of harbor-lines required for the island.

The line is delineated upon the accompanying map, and is described as follows:

The pier-head line begins at the point B at the western end of the pier-head line approved by the Secretary of War March 4, 1890, and runs westerly in a straight line to the eastern end of the approved pier and bulkhead line at Seguine's Point, 840 feet south of the base-line; thence along that line to its western end, 620 feet south of the base-line; thence westerly, by a gentle curve, along the 18-foot curve, approximately, to a point 75 feet north of the Prince's Bay Light and Seguine's Point base-line, 1,500 feet east of Prince's Bay Light; thence in a straight line to the outer extremity of the eastern wharf at Red Bank, 1,445 feet south of base-line; thence in a straight line to the outer extremity of the western wharf at Red Bank, 1,630 feet south of base-line; thence in a straight line to a point in the bay in the 6-foot curve, 2,700 feet south from the south side of Raritan avenue, measured along Aspinwall avenue extended southerly, and thence by a gentle curve to the westward and northward to the established pier and bulkhead line at Ward's Point, 40 feet westward of Station I.

Respectfully submitted.

HENRY L. ABBOT,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.
WM. P. CRAIGHILL,
Colonel of Engineers.
C. B. COMSTOCK,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.
D. C. HOUSTON,
Colonel of Engineers.
G. L. GILLESPIE,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
July 25, 1890.

Respectfully submitted to the Secretary of War.

The Harbor-Line Board for New York Harbor and its adjacent waters recommends for adoption a pier-head line for the west half of the south shore of Staten Island, from the western terminus of the pier-head line, established by the Secretary of War on that shore March 4, 1890, westward to Ward's Point, Staten Island. The line recommended completes the system of harbor-lines required for this island, and is fully described herein and delineated upon the chart accompanying.

It is recommended that the line selected be approved and that the Secretary place his approval both upon the report and upon the tracing submitted.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Second indorsement.]

WAR DEPARTMENT, *July* 26, 1890.

Approved.

L. A. GRANT,
Acting Secretary of War.

l. MODIFICATION OF PIER-HEAD LINE ON EAST SHORE OF EAST RIVER FROM NORTH FIRST STREET, BROOKLYN, TO BRIDGE ACROSS BUSHWICK CREEK AT KENT AVENUE.

NEW YORK CITY, *May* 21, 1890.

GENERAL: The Board of Engineers convened by Special Orders, No. 49, Headquarters Corps of Engineers, series of 1888, has the honor to submit the following report upon the petition of Havemeyers and Elder, and others, to the Secretary of War, requesting an extension of the legal pier lines on the Brooklyn side of East River from North Second street to North Tenth street, referred to the Board for report by your indorsement of April 2, 1890.

The harbor-lines along this front recommended by this Board and approved by the Secretary of War on February 8, 1890, were identical with the then existing legal lines established by chapter 763, laws of the State of New York of 1857. A modification of these lines had been recommended by Brig. Gen. John Newton, then Chief of Engineers, United States Army, on February 9, 1886, which was approved by the Secretary of War, Hon. William C. Endicott, on February 12, 1886; but this action being at that date extra official had no legal force, and the recommendation when laid before the State legislature failed to receive confirmation. No application for a modification of the established harbor-lines anywhere in this vicinity was made to this Board when these lines were considered at a duly advertised public-meeting on January 23, 1890, and a vigorous protest was received against the changes near the mouth of Bushwick Creek proposed by General Newton.

The petition of Havemeyers, Elder, and others, dated March 27, 1890, was considered at a duly advertised public meeting held at this place on April 15, 1890, and again on May 20, 1890, and a careful survey, which forms the basis of the map accompanying this report, was made between these dates. The site had been visited by the Board on April 14, 1890.

Testimony was adduced at these meetings establishing the fact that there is a very large commerce along the river front in question, and that an increased length of pier is desirable to accommodate the larger class of vessels now engaged in the traffic. Also that, as indicated on the map, piers have been extended into the river at North Fifth, North Sixth, and North Eighth streets considerably beyond the legal pier-head line. The pier at North Eighth street was built many years before the action of the War Department in 1886, above mentioned, and no claim that it has even a quasi legal existence has been presented. It is, however, claimed that the piers at North Fifth and North Sixth streets were built subsequent to and in consequence of that action; and, also, that for the same reason land has been purchased in the vicinity which would not subserve its purpose, and would not have been purchased except for the belief that the extension of the pier-head line proposed by General Newton and approved by the Secretary of War would be legalized. It was urged that the consent of the General Government has been accorded by that action, and that if an opportunity were afforded to the State authorities to legalize the extension even now it would be done.

The only opposition to the extension of the pier-head line in this vicinity developed at any of the meetings of the Board, was to that pro-

posed near the mouth of Bushwick Creek, which it was claimed, and it was thought justly, would be an injury to commerce and an infringement of vested rights. Attention was also called to the fact that the original map signed by General Newton and the Secretary of War in 1886 contains an important error in that the proposed extension begins at, and is apparently justified by, an imaginary pier at the mouth of Bushwich Creek projecting 286 feet farther than any which has now or which ever had an existence.

The Board has hesitated long to advise any extension whatever of the pier-head line where urged by the petitioners, for the reason that the unauthorized structures owned by them lie directly opposite Shell Reef, the worst part of the shoal extending from Grand street to Twenty-sixth street on the New York side. This reef contracts the legal navigable channel to a width of about 1,200 feet, and these structures reduce it still further to about 1,000 feet. The engorgement increases the strength of the local currents to about 4 nautical miles an hour, and thus adds another impediment to the free navigation of this crowded passage-way.

It was urged that this reef should be removed by the Government. A survey made in 1889 has shown that to obtain a depth of 21 feet will cost $1,029,942; and to obtain the full depth of 26 feet, which was adopted as the suitable standard at Hell Gate, will cost $4,942,718. The undertaking is therefore one of great magnitude, which in advance of Congressional action can not be considered in establishing harbor-lines to meet present requirements. It would seem that the increased length of slips desired might be more reasonably obtained by excavating landward, where, on the contrary, filling is now actually in progress to the full extent authorized by the bulkhead line.

In brief, under ordinary circumstances the rules which have governed this Board in its recommendations would forbid any extension of the pier-head line at this locality; but the action of the Government in 1886, above cited, has supplied the petitioners with so plausible a ground for their application that in equity some concession has seemed to be demanded. The following recommendation must therefore be regarded as in no sense a precedent for future action.

No change in the present legal bulkhead line is recommended, and that line is to be understood as the limit beyond which no solid filling of any kind shall be permitted, not even detached cribs filled with solid materials. A new pier-head line is recommended, which, while affording increased facilities to commerce, is not so objectionable as that proposed in 1886.

From a point determined by prolonging the north side of the pier next north of North Eleventh street 100 feet, a line drawn tangent to the present legal pier-head line near North First street to be the new pier-head line. Northward from the point thus established, the new line to consist of the arc of a circle having a radius of 325 feet and passing through said point to the north corner of the existing wharf at North Twelfth street. Thence the new line to follow the side of said wharf or structure to its junction with the legal bulkhead line, and thence to the south abutment of the Kent Avenue Bridge.

The line thus recommended is described more fully in the appended document marked A, and is also laid down on the accompanying map.

The petition of Havemeyers and Elder and others and the accompanying papers are herewith returned.

Respectfully submitted.

HENRY L. ABBOT,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.
WM. P. CRAIGHILL,
Colonel of Engineers.
C. B. COMSTOCK,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.
D. C. HOUSTON,
Colonel of Engineers.
G. L. GILLESPIE,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
June 5, 1890.

Respectfully submitted to the Secretary of War.

The Harbor-Line Board for New York Harbor and its adjacent waters, constituted by Special Orders No. 49, Headquarters Corps of Engineers, series of 1888, submits the within report upon the petition of Messrs. Havemeyers and Elder, and others, requesting an extension of the legal pier lines on the Brooklyn side of East River from North Second street to North Tenth street.

The Board gave the petition careful consideration, and, in accordance with the conclusions arrived at, recommends for approval a change in the pier-head line approved by the Secretary of War February 8, 1890.

The change recommended is in the pier-head line from North First street, Brooklyn, E. D., north and east to the south abutment of bridge across Bushwick Creek at Kent avenue, and is described in the accompanying paper marked A, and delineated on the accompanying chart.

It is recommended that the modification proposed be approved, and that the Secretary place his approval both upon the report and upon the tracing submitted.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Second indorsement.]

WAR DEPARTMENT, *June* 18, 1890.

Approved.

REDFIELD PROCTOR,
Secretary of War.

A.—DESCRIPTION OF THE CHANGE IN THE PIER-HEAD LINE FROM NORTH FIRST STREET, BROOKLYN, E. D., NORTH AND EAST TO THE SOUTH ABUTMENT OF BRIDGE ACROSS BUSHWICK CREEK AT KENT AVENUE, WHICH IS RECOMMENDED TO THE SECRETARY OF WAR FOR APPROVAL AND ADOPTION BY THE BOARD OF ENGINEERS FOR HARBOR LINES OF NEW YORK HARBOR, CONSTITUTED BY SPECIAL ORDERS NO. 49, HEADQUARTERS CORPS OF ENGINEERS, OCTOBER 5, 1888, IN A REPORT DATED MAY 21, 1890.

Beginning at a point in the pier-head line approved by the Secretary of War, February 8, 1890, said point being in a line 100 feet south of, and parallel to, the south

side of North First street, and 656 feet west of the west side of Kent avenue; thence northerly in a straight line [which line intersects the south side of North First street produced, 677 feet west of the west side of Kent avenue; the north side of North First street produced, 688 feet west of the west side of Kent avenue; the south side of North Second street produced, 736 feet west of the west side of Kent avenue; the north side of North Second street produced, 747 feet west of the west side of Kent avenue; the south side of North Third street produced, 796 feet west of the west side of Kent avenue; the north side of North Third street produced, 807 feet west of the west side of Kent avenue; the south side of North Fourth street produced, 854 feet west of the west side of Kent avenue; the north side of North Fourth street produced, 867 feet west of the west side of Kent avenue; the south side of North Fifth street produced, 910 feet west of the west side of Kent avenue; the north side of North Fifth street produced, 923 feet west of the west side of Kent avenue; the south side of North Sixth street produced, 966 feet west of the west side of Kent avenue; the north side of North Sixth street produced, 979 feet west of the west side of Kent avenue; the south side of North Seventh street produced, 1,022 feet west of the west side of Kent avenue; the north side of North Seventh street produced, 1,035 feet west of the west side of Kent avenue; the south side of North Eighth street produced, 1,078 feet west of the west side of Kent avenue; the north side of North Eighth street produced, 1,091 feet west of the west side of Kent avenue; the south side of North Ninth street produced, 1,133 feet west of the west side of Kent avenue; the north side of North Ninth street produced, 1,146 feet west of the west side of Kent avenue; the south side of North Tenth street produced, 1,189 feet west of the west side of Kent avenue; the north side of North Tenth street produced, 1,202 feet west of the west side of Kent avenue; the south side of North Eleventh street produced, 1,245 feet west of the west side of Kent avenue; the north side of North Eleventh street produced, 1,258 feet west of the west side of Kent avenue] to a point in a line 58 feet north of and parallel to the north side of North Eleventh street produced, westerly and 1,270 feet west of the west side of Kent avenue; thence easterly in a curve with a radius of 325 feet, intersecting the south side of North Twelfth street produced, 1,244 feet west of the west side of Kent avenue, and the north side of North Twelfth street produced, 1,210 feet west of the west side of Kent avenue, to a point in a line 48 feet north of and parallel to the north side of North Twelfth street produced, and 1,169 feet west of the west side of Kent avenue; thence easterly in a straight line to a point in a line 12 feet south of and parallel to the south side of North Thirteenth street and 908 feet west of the west side of Kent avenue; thence easterly in a straight line to a point in a line 50 feet north of and parallel to the south side of North Thirteenth street and 738 feet west of the west side of Kent avenue; thence easterly in a straight line to a point in a line 139 feet north of and parallel to the south side of North Thirteenth street, and 439 feet west of the west side of Kent avenue; thence easterly in a straight line to a point in a line 238 feet north of and parallel to the south side of North Thirteenth street, and 96 feet west of the west side of Kent avenue; thence easterly in a straight line to a point in a line 233 feet north of and parallel to the south side of North Thirteenth street and 50 feet west of the west side of Kent avenue; thence in a straight line to the intersection of the west side of Kent avenue with the south abutment of the bridge across Bushwick Creek, which intersection is 218 feet north of the south side of North Thirteenth street.

APPENDIX F.

IMPROVEMENT OF SHEEPSHEAD AND CANARSIE BAYS AND SUMPAWANUS INLET, NEW YORK; OF ARTHUR KILL, NEW YORK AND NEW JERSEY; OF CHANNEL BETWEEN STATEN ISLAND AND NEW JERSEY; OF RIVERS IN NORTHERN NEW JERSEY, AND OF THE HARBOR OF KEYPORT.

REPORT OF CAPTAIN THOS. L. CASEY, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1890, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Sheepshead Bay, New York.
2. Canarsie Bay, New York.
3. Sumpawanus Inlet, New York.
4. Arthur Kill, New York and New Jersey.
5. Channel between Staten Island and New Jersey.
6. Passaic River, New Jersey.
7. Elizabeth River, New Jersey.
8. Rahway River, New Jersey.
9. Raritan River, New Jersey.
10. South River, New Jersey.
11. Shrewsbury River, New Jersey.
12. Keyport Harbor, New Jersey.

UNITED STATES ENGINEER OFFICE,
New York, July 8, 1890.

GENERAL: I have the honor to transmit herewith my annual report on the works of river and harbor improvements in my charge for the fiscal year ending June 30, 1890.

Very respectfully,

THOS. L. CASEY,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers U. S. A.

F 1.

IMPROVEMENT OF SHEEPSHEAD BAY, NEW YORK.

Sheepshead Bay, Long Island, is a small tidal bay about 2 miles long, lying inside Coney Island, New York, and extending easterly from the village of Gravesend to Rockaway Inlet, into which it empties. Its width varies from 100 to 1,000 feet, and its depth from 0 to 10 feet at mean low water.

The natural entrance is subject to progressive changes of position, due to the action of the waves on the sandy beaches.

The first survey, with a view to its improvement, of which we have any record, was made in 1879 by General Newton, whose report, dated

February 7, 1879, may be found in the Annual Report of the Chief of Engineers for 1879, page 400.

The plan of improvement proposed provided for diking the channel and connecting it with Rockaway Inlet, the estimated cost being $100,000.

In 1882 a survey of the mouth of Rockaway Inlet was made which developed great changes in the shoals westward of it, and, based upon this, General Newton suggested making the outlet from Sheepshead Bay into Dead Horse Inlet, instead of directly into Rockaway Inlet as at first proposed.

Two plans, with estimates of the cost of doing this, were furnished, the first providing for diking as well as dredging, the second omitting the diking. They were as follows:

(1) Cut to connect Sheepshead Bay with Dead Horse Inlet, 100 feet wide, 6 feet deep at mean low water, 52,000 cubic yards, at 35 cents per cubic yard	$18,200
1,200 feet of creosoted diking to sustain bend in cut, at $6 per linear foot	7,200
7,500 feet of creosoted diking for interior channel, at $5 per linear foot	37,500
Total of first estimate	62,900
(2) Cut to connect Sheepshead Bay with Dead Horse Inlet, 100 feet wide, 6 feet deep at mean low water, 52,200 cubic yards, at 35 cents per cubic yard	18,200
Dredging interior channel, 40,000 cubic yards, at 35 cents per cubic yard	16,000
Total of second estimate	34,200

The second plan, which omits the diking, is the one that was adopted for the work.

Under this project $16,904.85 had been expended June 30, 1889, in dredging a channel 100 feet wide and 6 feet deep at mean low water, connecting the east end of the bay with Dead Horse Inlet. A survey made in 1887 shows that this channel has not maintained itself, having contracted to a width of 60 feet, with an average depth of 5½ feet mean low water.

The original project for the formation and maintenance of a dredged channel, 100 feet wide and 6 feet deep mean low water, was modified in February, 1889, the modified project contemplating a channel 5,350 feet long, 60 feet wide, and 5½ feet deep mean low water, from the town of Sheepshead to within 1,080 feet of Dead Horse Inlet Cut, to connect with the channel of similar width and depth already existing at that point.

A special agreement, approved June 12, 1889, was made with M. H. Flannery for doing the work at 25 cents per cubic yard, measured in scows. Work under this agreement was commenced July 12, 1889, and continued without interruption, excepting such as was made necessary by breakages of machinery and occasional storms, until the date of closing the agreement, December 6, 1889, when 27,025 cubic yards had been removed, giving a channel of the required width and depth 3,400 feet in length, extending from the town of Sheepshead toward Dead Horse Inlet. No opportunity has yet presented itself to determine the permanence of this channel.

The expenditures during the fiscal year ending June 30, 1890, amount to $8,375.12, as follows:

Cost of dredging 27,025 cubic yards, at 25 cents per cubic yard	$6,756.25
Cost of inspection	703.39
Cost of draughting	362.77
Cost of administration	552.71
Total	8,375.12

Sheepshead Bay is not a harbor in any sense of the word, and in all probability never will be. At present it is only used for pleasure boats of small draught, belonging to Gravesend and the large hotels on Coney Island.

There appears, therefore, to be no necessity for further appropriation at present.

The commerce of the bay was reported in 1887, valued at $50,000.

This work is in the collection district of New York, which is the nearest port of entry. Nearest light-house, Fort Tompkins Light; nearest fort, Fort Hamilton.

The amount of revenue collected at the port of New York during the year ending June 30, 1890, is $154,831,162.38.

Original estimate, 1879	$100,000.00
Revised estimate, 1882	34,200.00
Amount appropriated	26,000.00
Amount expended	25,286.52

Money statement.

July 1, 1889, amount available	$1,034.40
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	320.92
July 1, 1889, balance available	713.48
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	8,200.00

COMMERCIAL STATISTICS.

The following statistics relative to commerce of Sheepshead Bay, New York, were furnished by Messrs. Lundy & Daly, of Sheepshead Bay, New York, for the year ending December 31, 1889:

Articles.	Amount.	Value.	Vessels.	No.	Average draught.	Average tonnage.
	Tons.				*Feet.*	
Lumber	800	$16,000				
Stone (curb)	16,800	1,430,000	Sail	*12	5	15
Fish, clams, etc	17,400	382,800	Barges	25	5	175
Total	35,000	1,828,800		37		

*Average two trips per week.

The commerce of the Bay has increased about 800 tons over that reported in 1884.

F 2.

IMPROVEMENT OF CANARSIE BAY, NEW YORK.

The first survey of this bay with a view to its improvement was made in 1879. The scheme of improvement involved a channel 6 feet deep at mean low water, and 100 to 150 feet wide, extending from the shore at Canarsie Landing to the navigable channel in Jamaica Bay, a distance of about 3,500 feet. It was thought that the channel might be maintained by the construction of two pile dikes, forming a tidal reservoir. The estimated cost under this project was $88,000.

A detailed history of the work will be found in the Annual Report of the Chief of Engineers for 1887, Part I, page 637.

In regard to the portion of the contemplated improvement already completed, it should be stated that the main channel has been dredged to a width of from 100 to 125 feet, and a depth of 6 feet at mean low water from Canarsie Landing to the deep water of Jamaica Bay, except for a short distance, where the width obtained was only 50 feet; with additional appropriation it is intended to increase the width of the channel at this point to 100 feet.

There have also been several minor improvements not contemplated in the original project, for the prosecution of which permission was, in each case, obtained from the Department (see Report for 1889). Among these should be mentioned a cut 100 feet in length, 50 feet wide and 6 feet deep, on the east side of the steam-boat landing at Canarsie, for use as a turning basin; also a cut at the end of the wharf at Canarsie Landing, and its subsequent extension through to the southwest, to connect with the Southwest Channel.

This southwest cut was intended to serve the two-fold purpose of an avenue of communication with the Southwest Channel, and as an opening for the tidal currents, which it was hoped would maintain the depth opposite the wharves and through the main channel. Special permission was obtained October 10, 1889, for the hire of dredging plant for this purpose, at $60 per day. Work began October 10, and a cut 1,193 feet in length, 25 feet wide, and 5 feet deep at mean low water, completed on October 26, at a cost of $855. The material was thrown up on each side of the cut, openings being left at intervals for the convenience of small boats in entering the channel from the adjoining landing places. According to recent informal reports the depth of water in the cut seems to be maintained.

The 1,058 feet of dike along the northern edge of the channel, near its entrance to the deep water of Jamaica Bay, appears to be in a satisfactory state of preservation, but it is a question whether it is of much real importance in maintaining the channel; no addition to it is contemplated at present, or until the effect of floating ice during a hard winter can be observed.

The mean tidal range is about 4.7 feet.

The commerce of the bay was reported in 1887 to be about 21,575 tons, valued at $319,750; this has increased to 26,262 tons, valued at $449,250 during 1889.

The expenditures during the past fiscal year amount to $1,085.25, as follows:

Fourteen and one-fourth days hire of dredging plant, at $60 per day	$855.00
Cost of inspection	145.15
Cost of administration	95.10
Total	1,095.25

Canarsie Landing, besides being the terminus of the Brooklyn, Rockaway Beach, and Jamaica Bay Railroad, from which passengers are transshiped by steamer to Rockaway Beach, has a large fishing industry.

It is thought that $10,000 will be sufficient to complete the channel and repair the dikes, and an appropriation of this amount is therefore recommended.

The amount expended on this improvement to June 30, 1890, is $42,485.99.

This work is in the collection district of New York, which is the nearest port of entry. Nearest light-house, Fort Tompkins Light. Nearest fort, Fort Hamilton.

The amount of revenue collected at the port of New York during the fiscal year ending June 30, 1890, $154,831,162.38.

Original estimate	$88,000.00
Amount appropriated	43,000.00
Amount expended	42,485.99

Money statement.

July 1, 1889, amount available	$1,607.26
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,093.25
July 1, 1890, balance available	514.01
Amount appropriated by act of September 19, 1890	5,000.00
Amount available for fiscal year ending June 30, 1891	5,514.01
Amount (estimated) required for completion of existing project	40,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	10,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

The following statistics relative to commerce of Canarsie Bay, New York, for the year ending December 31, 1889, were kindly furnished by Mr. William Warner, superintendent of the Brooklyn, Rockaway Beach and Jamaica Bay Railroad.

Articles.	Amount.	Value.	Vessels.	No.	Average draught.	Average tonnage.
	Tons.				*Feet.*	
Oysters and clams	12,750	$296,000				
Fish	512	51,250	Steam	4	5½	150
Coal	3,000	12,000	Sail	60	3½	10
Fertilizers	10,000	100,000				
Total	26,262	449,250		64		

The above table shows an increase in the commerce of this water-way of 5,562 tons over that reported in 1887.

F 3.

IMPROVEMENT OF SUMPAWANUS INLET, NEW YORK.

Sumpawanus Inlet, known in the neighborhood and on the Coast Survey charts as Sumpawams Creek, is a small creek on the south side of Long Island, emptying into the Great South Bay.

It lies about 36 miles east of New York City, 15 miles east of the western end of the Great South Bay, and nearly twice as far from its eastern end.

Fire Island Inlet, through which most of the waters of Great South Bay pass into the Atlantic Ocean, lies south-southeast of Sumpawams Creek, distant about 6 miles in a direct line, but 11 miles by the channel.

The inlet is a tidal stream from 100 to 200 feet wide, running up to the town of Babylon, Long Island, which lies less than a mile north of the mouth. It is crossed here by a dam, which forms a reservoir for the fresh water of a small creek which supplies the town with water.

The mean rise and fall of the tides at the mouth of the inlet is only 1.3 feet, and the bottom of the bay and of the inlet is soft mud.

The first survey of Sumpawams Creek of which we have any record was ordered by act of Congress, approved June 14, 1880, and was made during the fall of 1881, under the direction of General (then Colonel) John Newton, Corps of Engineers.

His report may be found in the Annual Report of the Chief of Engineers for 1881, Part I, page 653.

The project of improvement, based upon this survey, provided for dredging a channel 150 feet wide and 5 feet deep at mean low water from the 5-foot curve in the bay to the steam-boat dock at the mouth of the creek, a distance of about 1,500 feet, and thence 5 feet deep and 100 feet wide up the inlet to the town of Babylon, a distance of about 3,500 feet farther. The estimated cost of making this improvement was $23,115.

The mean range of tides at the mouth of the inlet being only 1.3 feet, there was practically no current swift enough to produce scour. The depth of water in the proposed channel, at the time of the survey, was from 1 to 3 feet in the creek and from 3 to 5 feet outside.

It was not believed that diking would assist in improving this entrance, and inquiry showed that the depth of water both outside and inside the inlet had materially diminished in late years.

The amount expended under the project to June 30, 1889, was $6,982.87, giving a channel 75 feet wide and 5 feet deep from the steam-boat wharf to a point 750 feet below it, besides two cuts, each 25 feet wide, alongside the wharf.

Outside of the cuts so made and extending to the 5-foot curve in the bay a shoal was left on which the depth was only about 4¾ feet.

An examination made in 1886 showed that since the last dredging was done, in 1883, both the cut and the flat outside had shoaled from 6 inches to 1 foot, the depth in the cut being about 5 feet, while on the flat it was from 4 to 4½ feet. This was to have been anticipated, as appears by the preliminary report made by General Newton. The 5-foot curve in the bay was 1,500 feet from the steam-boat wharf, but inside this curve, for about 750 feet towards the wharf, lay the flat.

The commerce of Sumpawams Creek is essentially that of Babylon, a small town of from 3,000 to 5,000 inhabitants, 1 mile above the mouth of the creek, depending almost entirely upon summer trade of the hotels and cottages along the north shore of Great South Bay and on Fire Island Beach.

The commerce of Babylon by water has been decreased, apparently because the Long Island Railroad has taken away the sea-going business. Babylon itself has improved, and has become a fashionable summer resort. At present its commerce by sea is carried on by three passenger steamboats, drawing from 4 to 5 feet, running in summer to Fire Island Beach; three schooners, drawing from 5 to 5½ feet, carrying brick, lime, lumber, and other heavy freight to Babylon the year round; one hundred sloops and pleasure boats, drawing from 1 to 2 feet of water, taking out sailing and fishing parties in summer, of which seven or eight remain in use during the winter, fishing and taking oysters and clams to Patchogue, Sayville, and New York.

The commerce of the creek, in my judgment, does not warrant the formation of a channel more than 5 feet deep from the 5-foot curve in the bay to the steam-boat wharf for the convenience of the few steamers and schooners which make use of the creek.

It is stated that the shoals in the bay kill the sea so entirely that pleasure boats can now lie in the mouth of the creek in all weather.

So far as the extension of the improvement from the steam-boat dock up to the inlet is concerned, there appears to be no reason why the Government of the United States should undertake it.

The original estimate of the cost of the work was $23,115. Seven thousand dollars have been appropriated.

Ten thousand dollars can be expended in giving a 5-foot channel out into the bay for the use of steam-boats, but I think that the work is more a matter of local than public interest.

This work is in the collection district of New York, which is the nearest port of entry. Nearest light-house, Fire Island Light. Nearest fort, Fort Hamilton.

The amount of revenue collected at the port of New York during the fiscal year ending June 30, 1890, was $154,831,162.38

Original estimate	$23,115
Amount appropriated	7,000
Amount expended	7,000

Money statement.

July 1, 1889, amount available	$17.13
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	17.13
Amount (estimated) required for completion of existing project	16,115.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

The following statistics relative to commerce of Sumpawanus Inlet, New York, during the past year, were kindly furnished by Hon. Jas. B. Cooper, justice of the peace, Babylon, Long Island:

Articles.	Amount.	Value.	Vessels.	No.	Average draught.	Average tonnage.
	Tons.				*Feet.*	
Oysters and clams	60	$24,000	Steam	10	4½	90
Fish	200	24,000	Sail	380	3	10
Building material	1,000	8,500				
Miscellaneous	18	1,800				
Total	1,278	58,300		390		

The steam-boats running to and from Fire Island Beach carried 10,000 passengers during the past year.

F 4.

IMPROVEMENT OF ARTHUR KILL, NEW YORK AND NEW JERSEY.

A history of this improvement, which originated by special resolution of the Committee of Commerce in the Senate, is given in the Annual Report of the Chief of Engineers for 1889, Part I, page 819.

The condemnation proceedings for the acquisition of the land forming Steep Point, by the removal of which it was hoped to direct the flood currents more truly in a direction perpendicular to the axial line of the

Staten Island Bridge, were perfected in the United States court for the eastern district of New York, on November 8, 1889. The amount of the award for tract No. 1, as described in the order of the court, was $312.50, and for tract No. 2, also as described therein, $500. The total award, amounting to $812.50, was approved by the Secretary of War December 13, 1889, and payment for tract No. 1, which comprised 1.29 acres, was made February 5, 1890, to Jacob Hatfield. On January 13 there had been deposited in registry, in conformity with an order of the court, $500 as payment for tract No. 2, containing 0.22 acres, then still in dispute as to ownership by Messrs. Hatfield and Drake.

The portion of the original appropriation which was expended by June 30, 1889, in part purchase of tug-boat and office administration, amounted to $974.35, this in addition to the expenditure of the above-mentioned $812.50 for the purchase of the land, and of the attorney's, commissioner's and stenographer's fees during the condemnation proceedings, amounting to $4-3.18, left a balance of $7,729.97 for the prosecution of the improvement. A project for the expenditure of this balance was submitted January 21, and was approved by the Secretary of War January 29, 1890.

This project contemplates the removal of Steep Point by dredging and excavation in cuts parallel to the bulkhead lines shown on the map accompanying the Annual Report for 1889. Authority to advertise the work was granted February 6, 1890, and bids (abstract herewith) were opened March 3. The lowest bid, that of R. G. Packard, at 23½ cents per cubic yard, measured in scows, being approved, a contract was entered into March 24 for the removal of 29,000 cubic yards, more or less, in the manner detailed in the preceding paragraph. Work began under this contract April 9 and was concluded May 20, 1890, the amount of material removed having been 29,000 cubic yards.

By this means the channel has been widened by 150 feet to a depth of 13 feet at mean low water, the amount of land removed being one-half acre.

A complete set of current measurements was made on both the ebb and flood by Mr. C. S. Kelsey, assistant engineer, May 28 to 31, and a comparison of the flood threads thus obtained with those taken before the removal of the point is shown on the accompanying map. It will be noticed that there has been a decided rectification of the flood currents in the neighborhood of the point.

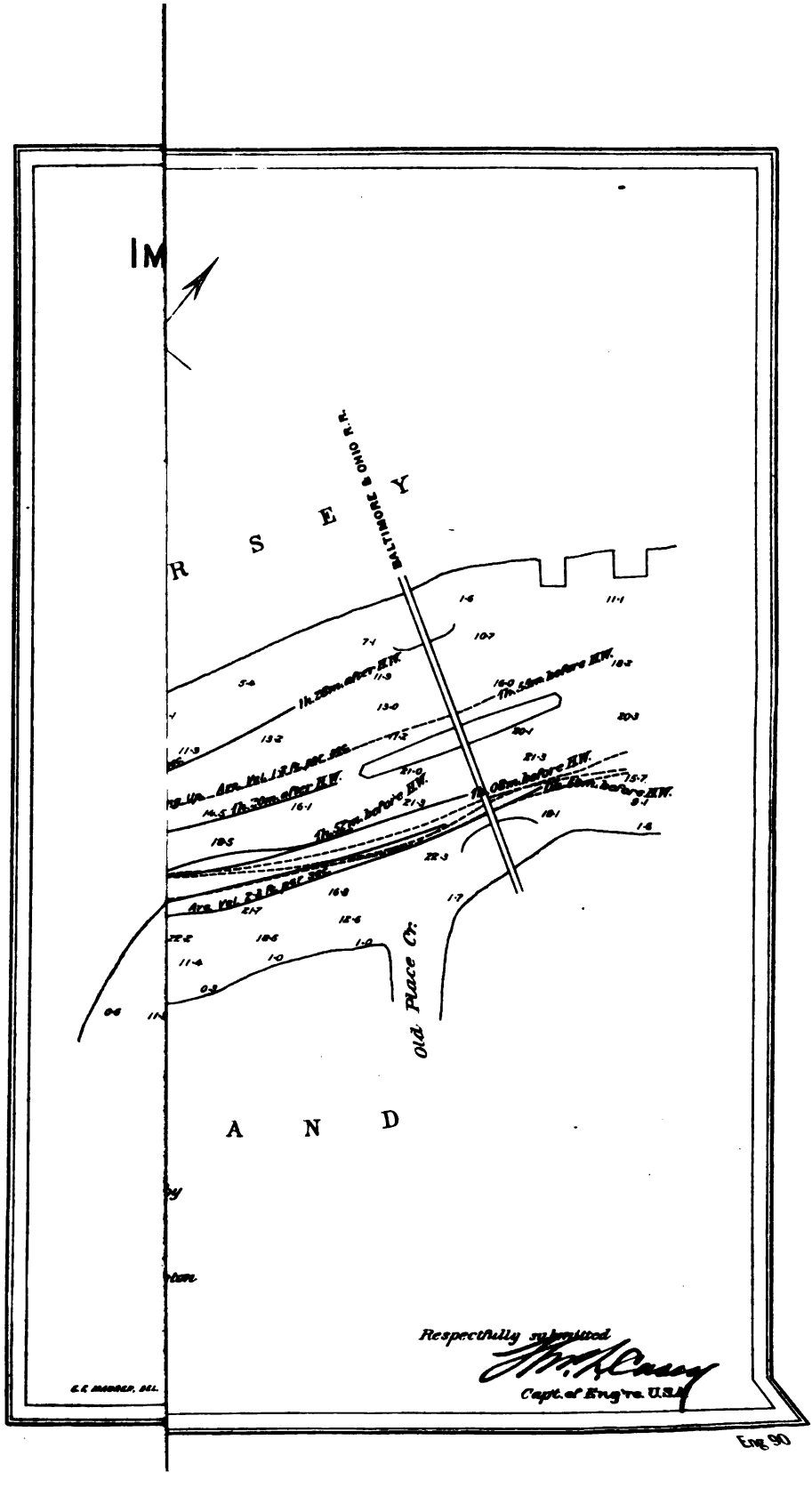
It is thought that the remaining acre of land can be removed at a cost of about $10,000, the appropriation of which is hereby recommended for the fiscal year ending June 30, 1892.

The expenditures for the fiscal year ending June 30, 1890, amount to $2,161.15 as follows:

Cost of land	$812.50
Cost of legal fees	483.18
Cost of advertising	68.50
Cost of survey	139.16
Cost of draughting	75.00
Cost of inspection	143 34
Cost of administration	439.37
Total	2,161.15

The commerce, as reported for the calendar year ending December 31, 1889, is valued at $68,353.490.

This work is in the collection district of New York, which is the nearest port of entry; nearest light-house, Bergen Point Light; nearest fort, Fort Tompkins.


IM
R S E Y
A N D
BALTIMORE & OHIO R.R.
Old Place Cr.
Respectfully submitted
Capt. of Eng'rs. U.S.A.
E.E. MARKLEY, DEL.

Eng 90

The amount of revenue collected at the port of New York during the year ending June 30, 1890, is $154,831,162.38

Original estimate	$26,500.00
Amount appropriated	10,000.00
Amount expended	3,135.50

Money statement.

July 1, 1889, amount available		$9,025.65
July 1, 1890, amount expended during fiscal year, exclusive of liabitities outstanding July 1, 1889	$2,161.15	
July 1, 1890, outstanding liabilities*	6,832.25	
		8,993.40
July 1, 1890, balance available		32.25
Amount appropriated by act of September 19, 1890		7,000.00
Amount available for fiscal year ending June 30, 1891		7,032.25
Amount (estimated) required for completion of existing project		9,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1892		9,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of bids for improving Arthur Kill between Staten Island and New Jersey, New York and New Jersey, by dredging, opened at the United States Engineer Office, room 79, Army Building, New York, N. Y., at 12 o'clock m., on Monday, March 3, 1890, under advertisement dated February 3, 1890.

	Name and residence of bidder.	Name and residence of sureties.	Price bid per cubic yard measured in scows.	Total amount of bid.
			Cents.	
1	Morris and Cumings Dredging Company, New York City, N. Y.	James D. Leary, New York, N. Y.; Alex. Forbes, New York, N. Y.	24	$7,000
2	R. G. Packard, New York City, N. Y.	Thomas Walsh, New York, N. Y.; Augustine Walsh, New York, N. Y.	23½	7,000
3	M. H. Flannery, New York City, N. Y.	John J. Moloney, New York, N. Y.; Frank T. Fitzgerald, New York, N. Y.	25	7,000

Amount available for dredging $7,000.

COMMERCIAL STATISTICS.

The following statistics relative to the shipments through the Arthur Kill during the calendar year 1889 have been compiled from statements furnished by the firms located along its banks, and the entire traffic of the Raritan and South rivers, which passes over this water-way.

Articles.	Amount.	Value.	Vessels.	No.	Average draught.	Average tonnage.
	Tons.				*Feet.*	
Coal	5,395,568	$16,666,400	Steam	4,430	11	970
Building material	573,840	3,340,580	Sail	11,602	9	380
Miscellaneous	726,428	48,346,510	Barges	13,988	8	430
			Rafts	5,373	5	.....
Total	6,745,836	68,353,490	.....	35,393	.....	.....

*Owing to the absence of the contractor abroad the above amount due on the contract for dredging had not been paid at the close of the fiscal year.

F 5.

IMPROVEMENT OF CHANNEL BETWEEN STATEN ISLAND AND NEW JERSEY.

A description of this channel and a complete history of the work done towards its improvement may be found in the Annual Report of the Chief of Engineers for 1887, Part I, page 743.

Thus far the improvement has been confined to that part of the channel, about 1¾ miles long, which lies to the east of Elizabethport, N. J., and at the mouth of Newark Bay. This originally had a depth of only 9½ feet at mean low water, while the remainder, lying between the shores of Staten Island and New Jersey, had a depth of from 14 to 40 feet at mean low water.

The first project for the improvement of this channel was made in 1873. This provided for dredging it to a depth of 16 feet for a width of 150 feet at its shallowest part, and protecting the cut by parallel dikes. The estimated cost of this was $443,210. Fifty thousand dollars of this amount, appropriated in 1884, was spent in 1874–'75 in the construction of 2,227 feet of the south dike, opposite Elizabethport.

Great opposition being made to this plan by oyster-men and tow-boatmen, it was decided to modify it, and the project was therefore changed in 1880 so as to dredge a channel 400 feet wide and 13 feet deep over the middle 200 feet of its width, leaving it but 12 feet deep over the remaining widths of 100 feet on each side. The estimated cost of this work was $125,705. In addition to this it was proposed, should it be found necessary, to build four detached dikes along the line of the channel, two on the north and two on the south side, the estimated cost of which was $60,000, bringing the total estimated cost of the proposed improvement up to $185,705.

A modification of this project, having in view the abandonment of the dikes, was submitted May 9, 1889, and was approved by Department letter dated May 15, and at the same time permission was granted to expend the $15,000 appropriated by act of August 11, 1888, by contract, after advertisement in accordance with regulations. Specifications were prepared and duly advertised under date of May 24, and the bids were opened June 24, 1889. (See Annual Report for 1889, Part I, page 823.) The only bidder was Mr. Thomas H. Benton, at 27 cents per cubic yard, measured in scows. The bid was approved June 28, 1889.

The contract with Mr. Benton for dredging 44,000 cubic yards, more or less, was entered into July 18, 1889. Work began August 8 and the contract was closed October 11, 1889, the total amount of material removed being 44,041 cubic yards. Under this contract the channel in the vicinity of the Corner Stake Light has been given an additional width of 100 feet and a depth of 13 feet at mean low water for a distance of 1,800 feet, the excavation being made from the north side of the channel. Between the Corner Stake Light and Long Dock it was widened by 70 feet through a distance of 1,000 feet, and by 35 feet for a further distance of 750 feet, with a depth of 13 feet at mean low water, the excavation being made in both the latter sections from the south side of the channel.

This dredging has resulted in considerable improvement of the channel in regard to width, which, because of the sharp turn at the Corner Stake Light, should be as great as is consistent with the maintaining power of the current. In my last report it was recommended that at this point the channel should be widened to 400 feet, with a depth throughout of 13 feet at mean low water, at a total estimated cost of $30,000.

From statistics compiled for the fiscal year ending June 30, 1887, the total shipping passing the Stake Light was shown to be 8,442,439 tons, valued at $67,539,512; this was increased during the fiscal year just concluded to 8,822,071 tons, valued at $94,091,422.

The expenditures during the past fiscal year amount to $13,314.42, as follows:

Cost of dredging	$11,891.07
Cost of inspection	433.53
Cost of advertising	46.32
Cost of examination	157.17
Cost of draughting	150.00
Cost of administration	636.33
Total	13,314.42

The estimated amount required to complete the existing project is $76,000, of which $30,000 can be profitably expended during the fiscal year ending June 30, 1892.

This work is in the collection district of New York, which is the nearest port of entry. Nearest light-house, Bergen Point Light; nearest fort, Fort Tompkins.

The amount expended to June 20, 1889, was $170,312.73.

The amount of revenue collected at the port of New York during the fiscal year ending June 30, 1890, $154,831,162.38.

Original estimate (1873)	$443,210.00
Revised estimate (1880)	185,705.00
Revised estimate (1883)	210,000.00
Amount appropriated	184,000.00
Amount expended	183,627.15

Money statement.

July 1, 1889, amount available	$1,612.65
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,239.80
July 1, 1890, balance available	372.85
Amount appropriated by act of September 19, 1890	15,000.00
Amount available for fiscal year ending June 30, 1891	15,372.85
Amount (estimated) required for completion of existing project	61,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	30,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

The following statistics relative to the shipments through the channel during the calendar year 1889 have been compiled from statements furnished by the principal shippers over this water-way.

Articles.	Amount.	Value.	Vessels.	No.	Average Draught.	Average Tonnage.
	Tons.				*Feet.*	
Coal	5,848,469	$18,455,295	Steam	20,268	11	691
Building materials	992,345	8,815,861	Sail	11,457	9	370
Iron and ores	337,776	13,436,390	Barges	14,294	9	320
Fertilizers	302,500	10,450,000	Rafts	1,458	5	.....
Miscellaneous	1,340,981	42,933,876	.....	.....	.....	.....
Total	8,822,071	94,091,422	.....	47,477	.....	.....

The commerce of the channel has increased 379,632 tons over that reported in 1887.

F 6.

IMPROVEMENT OF PASSAIC RIVER, NEW JERSEY.

The Passaic River is being improved under two separate projects, the first applying to the river above Center Street Bridge, Newark, as far as Passaic, a distance of 8 miles, he second to the lower course of the river, from Center Street Bridge to and beyond the shoal in Newark Bay, a distance of 7⅝ miles.

For various reasons, both scientific and economical, it is highly desirable that these projects and accompanying appropriations should be united in order that the funds may be expended at those points, the treatment of which will best conduce to the regulation of the tidal portion of the river in its entirety.

1.—ABOVE NEWARK.

Before its improvement was undertaken the upper part of the river had a navigable 6 foot channel, except at Middle, Belville, Rutherford Park, and Holzman's bars, where the depths were 4.5 feet, 3.9 feet, 3 feet, and 3.5 feet, respectively.

The project of improvement was adopted in 1872, and provided for a channel across and above the shoals from 7½ to 6 feet deep at mean low water, and from 200 to 50 feet wide, to be obtained by dredging and diking, at a cost of $123,924. It was modified in 1885 by extending the channel below Middle Bar 1,500 feet to the Erie Railroad Bridge, increasing the estimate to $129,000, which was still further increased in 1886 to $133,762.

Under this project $127,816.46 had been expended to June 30, 1889, and channels of the requisite depth had been dredged from 60 to 75 feet wide, excepting for a distance of 1,500 feet above the Erie Railroad Bridge. Of the above amount, $3,254.25 was expended from the appropriation for this improvement as its pro rata share of a dredging plant, which consists of 1 dipper-dredge, 3 dump-scows, and 1 tug-boat, and purchased for this district at a total cost of $44,690.

The expenditures during the fiscal year amount to $1,885.82, as follows:

Cost of field work of survey	$1,130.00
Cost of draughting same	300.00
Cost of draughting (old records)	116.58
Cost of administration	339.24
Total	1,885.82

The only active work during the past fiscal year has been the prosecution of an extensive and minute hydrographic survey of the entire river included within the limits of this improvement, and extending from the Pennsylvania Railroad Bridge at Center street, Newark, to the town of Passaic. The survey was ably conducted under the immediate superintendence of Mr. C. S. Kelsey, and has been entirely reduced and plotted; it was begun July 8, 1889, and the field work completed September 14, 1889, the total cost being $1,430.

The commerce, although by no means as extensive as that of the lower portion of the river, appears to be increasing rapidly, the value of the tonnage passing the Center Street Draw-Bridge being $2,545.077.

The estimated amount required to complete the existing project is

)8,199.79, making allowance for the money expended in purchasing the)lant aboved allude to.

Passaic River is in the collection district of Newark, which is the nearest port of ntry. Nearest light-house, Passaic Light, at the lower end of dike in Newark Bay. Fort Tompkins is the nearest fort.

Amount of revenue collected during the fiscal year ending June 30, 1890, $6,026.19.

)riginal estimate (1872)	$123,924.00
Revised estimate (1886)	133,762.00
Amount appropriated	133,750.00
Amount expended	129,702.28

Money statement.

July 1, 1889, amount available	$5,933.54
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	1,885.82
July 1, 1890, balance available	4,047.72
Amount appropriated by act of September 19, 1890	5,100.00
Amount available for fiscal year ending June 30, 1891	9,147.72
Amount that can be profitably expended in fiscal year ending June 30, 1892 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	8,200,000

COMMERCIAL STATISTICS.

The following statistics relative to commerce of Passaic River, New Jersey, above Newark, during the year 1889, were compiled from statements furnished by parties making shipments over this stream:

Articles.	Amount.	Value.	Vessels.	No.	Average draught.	Average tonnage.
	Tons.				*Feet.*	
Building material	127,360	$1,384,281	Steam	210	7½	220
Coal	90,904	368,741	Sail	480	8	175
Iron	1,200	70,800	Barges	705	7½	200
Miscellaneous	95,973	721,255	Canal-boats	96	6	150
Total	*315,437	2,545,077		1,491		

* Increased about 217,837 tons over that reported in 1884.

2.—BELOW NEWARK.

The lower portion of the river, from the Center Street Bridge to Newark Bay, was first surveyed by the Engineer Department in 1879. The greatest depth in the channel at a point above the Elbow Beacon was only 7.1 feet, and in many places the greatest depth was 7.5 feet at mean low water. A project was adopted, based on this survey, providing for obtaining, by diking and dredging, a channel 200 feet wide and 10 feet deep at mean low water from Center Street Bridge to Newark Bay, at a cost of $232,875.

This project was modified in 1884, pursuant to the river and harbor act of that year, providing for extending the dike at the mouth of the river into the bay a distance of 12,000 feet, and for dredging a channel across the shoal in Newark Bay 200 feet wide and 10 feet deep at mean low water, increasing the original estimate to $353,875.

At the date of June 30, 1889, $181,137.84 had been expended, of

which $11,802.25 consisted of a pro rata share of expense incurred in providing the district with a complete dredging plant enumerated under the preceding improvement. The remainder, expended directly under the modified project, had sufficed to construct 6,205 feet of the dike at the mouth of the river, to dredge the channel through the shoal in the bay and as far as the Newark and New York Railroad Bridge to the required dimensions, and to carry the 10-foot channel with widths varying from 100 to 130 feet thence up the river as far as the Center Street Bridge, Newark.

The work during the past fiscal year has resulted in widening the 10-foot channel by 100 feet from the Newark and New York Railroad Bridge upward for a distance of 1,423 feet. The channel was also redredged to 10 feet depth at mean low water and widened to 180 feet for an additional distance of 1,150 feet, and around the bend above the toll-bridge the channel was regulated to a width of 100 feet and a depth of 10 feet at mean low water for a further distance of 2,975 feet to Lister's Dock. No examination has yet been made of this improved channel, but it is believed that the forthcoming survey will show that it has maintained itself. A large number of the representative wharf owners of Newark are earnestly in favor of widening the channel, within the wharf limits of Newark, to the full width of the river, a plan which appears to be worthy of adoption.

This work was done under contract instead of by hired labor as originally contemplated, permission to do so having been obtained August 14, 1889. Specifications were prepared and sealed proposals invited by advertisement under date of August 15, 1889, for dredging the channel between the Newark and New York Railroad Bridge and Lister's Dock, Newark, to a width of 200 feet and a depth of 10 feet at mean low water. Bids were opened September 16, 1889, the lowest bidder being R. G. Packard, at 22 cents per cubic yard, scow measurement (abstract herewith). The bid was approved and a contract entered into October 3, 1889, for dredging 68,000 cubic yards, more or less. Work was begun October 17 and the contract closed January 8, 1890, after the removal of 66,008 cubic yards of material. In this work two machines were continually occupied in dredging the material, which was deposited along the dike below the mouth of the river, and thrown over the dike by a third dredge of ample power and great length of boom.

The dike at the mouth of the river, extending into the bay, is in a fair state of preservation, and appears to maintain the channel. On September, 25, 1889, the office was informed of an illegal occupation of this dike by Messrs. Shanley, contractors for the Waverly and New York Bay Railroad Company, in constructing a roadway across the flats from the meadow bank to the dike, a distance of about 2,700 feet, intended as the western approach to a bridge to be built by this company across the bay. The Department was at once informed of the trespass, and the matter placed in the hands of the United States attorney for the district of New Jersey. The Messrs. Shanley acknowledged the service of the injunction restraining them from using the dike on November 25, and requested that it might be so modified as to enable them to proceed with their contract. This was referred to me, and on December 26 a revocable license was granted by the Secretary of War.

On January 27, 1890, a report, with accompanying map, was, by request, made to the New York harbor-line board, relating to the filling behind the dike by the Messrs. Shanley, as above mentioned.

The expenditures for the fiscal year amount to $17,120.43 as follows:

Cost of dredging	$14,521.76
Cost of inspection	979.44
Cost of draughting	250.00
Cost of advertising	48.55
Cost of fixtures for United States dredging plant	375.88
Cost of administration	944.80
Total	17,150.43

The estimated amount required for the completion of the existing project is $154,375, and of this it is estimated that $100,000 might profitably be expended during the fiscal year ending June 30, 1892, in widening the channel to the dimensions required by the existing project and in the construction of the river dikes.

Passaic River is in the collection district of Newark, which is the nearest port of entry. Nearest light-houses, Passaic lights, at lower end of the dike in Newark Bay. Fort Tompkins is the nearest fort.

Amount of revenue collected at the port of Newark, N. J., during the fiscal year is $6,026.19.

Original estimate (1879)	$232,875.00
Revised estimate (1884)	353,875.00
Amount appropriated	199,500.00
Amount expended	198,258.27

Mr. P. T. Quinn, secretary of the Board of Trade, Newark, N. J., reports the commerce of this river as having increased about 10 per cent. during the past year; it is now estimated at 1,300,000 tons annually. Twenty-seven thousand and thirty-six vessels passed the draw at the mouth of the river as against 22,317 in 1888.

Money statement.

July 1, 1889, amount available	$18,269.53
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	17,027.80
July 1, 1890, balance available	1,241.73
Amount appropriated by act of September 19, 1890	40,000.00
Amount available for fiscal year ending June 30, 1891	41,241.73
Amount (estimated) required for completion of existing project	114,375.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	100,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of bids for dredging the channel in the Passaic River, New Jersey, from the Newark and New York Railroad Bridge to Lister's Dock, Newark, opened at the United States engineer office, room 79, Army Building, New York, at 12 o'clock m. on September 16, 1889, under advertisement dated August 15, 1889.

No.	Name and residence of bidder.	Name and residence of sureties.	Price bid per cubic yard measured in scows.	Total amount of bid.
			Cents.	
1	P. Sanford Ross, 113 Hudson Street, Jersey City, N. J.	John Smith, Jersey City, N. J.; F. A Smith, Jersey City, N. J.	22½	$15,000
2	R. G. Packard, 34 Pine Street, New York City.	Augustine Walsh, New York City; Thomas Walsh, New York City.	22	15,000

Amount available for dredging $15,000

COMMERCIAL STATISTICS.

The following statistics relative to commerce of Passiac River, New Jersey, below Newark, were kindly furnished by Mr. P. T. Quinn, secretary of the Board of Trade, Newark N. J., for the year ending December 31, 1889:

Articles.	Amount.	Value.	Vessels.	No.	Average draught.	Average tonnage.
	Tons.				*Feet.*	
Coal	203,500	$855,250	Steam	12,221	9	475
Fertilizers	302,500	10,450,000	Sail	6,903	8	200
Ice	143,000	429,000	Barges	6,172	6	20
Iron and ores	195,800	9,625,000	Rafts	45	.....	.....
Building material	293,315	3,635,000	.....	.....	.....	.....
Grain and malt	21,880	698,500	.....	.....	.....	.....
Miscellaneous	180,000	19,030,000	.....	.....	.....	.....
Total	1,339,995	44,722,750	.....	25,341	.....	.....

The above table shows an increase of about 121,728 tons over that reported in 1887.

F 7.

IMPROVEMENT OF ELIZABETH RIVER, NEW JERSEY.

This stream, which is 2⅝ miles in length from its mouth to the head of navigation, at Broad street, Elizabeth, has a width of from 50 to 90 feet, and before its improvement the wharves in the city could only be reached at high water by vessels drawing less than 4 feet. Its commerce was estimated at 45,000 tons annually. The range of the tide was about 4.7 feet at its mouth and 3.4 feet at Bridge street.

The project for the improvement was adopted in 1878, and provides for obtaining by dredging a channel 60 feet wide and 7 feet deep at high water from the mouth of the river to the head of navigation at an estimated cost of $25,530.

The amount expended under this project to June 30, 1889, was $26,900.85, and a channel has been dredged to the required depth to within 1,000 feet of the Broad Street Bridge. A slight increase in the commerce of the stream had been observed.

There has been no appropriation for this work since 1882, and the expenditures during the last fiscal year have been $99.15 for office expenses.

The condition of the river has deteriorated since work was suspended. When last examined vessels drawing 5 feet could ascend the river to the head of the dredged channel at high tide. The commerce of the river is about 39,000 tons, but no substantial increase can be expected while the river remains in its present condition.

If it is the intention of Congress to complete this improvement the balance of the estimate, $16,160, would be expended profitably as regards the efficient prosecution of the work during the fiscal year ending June 30, 1892, and would be applied to dredging the channel to the full dimensions required by the project.

The estimated amount required for the completion of the improvement is $16,160.

Elizabeth is in the collection district of Newark, N. J. Nearest light-house, Bergen Point Light. Nearest fort, Fort Tompkins.

Amount of revenue collected at the port of Newark, N. J., during the fiscal year ending June 30, 1890, $6,026.19.

Original estimate (1878)	$25,530
Revised estimate (1882)	43,160
Amount appropriated	27,000
Amount expended	27,000

Money statement.

July 1, 1889, amount available	$75.75
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	75.75
Amount appropriated by act of September 19, 1890	5,000.00
Amount (estimated) required for completion of existing project	11,160.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	11,160.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

The following statistics relative to commerce of Elizabeth River, New Jersey, during the past year were kindly furnished by Thos. H. Benton, of Elizabethport, N. J.:

Articles.	Amount.	Value.	Vessels.	No.	Average draught.	Average tonnage.
	Tons.				*Feet.*	
Rope	3,000	$850,000	Sail	119	7	100
Building material	15,450	131,000	Barges	215	7	100
Hemp and flax	7,000	1,500,000		.....	.....	.....
Coal	14,000	61,000				
				334	7	100
Total	39,450	2,542,000				

The commerce of this river has increased about 9,450 tons during the calendar year ending December 31, 1889.

F 8.

IMPROVEMENT OF RAHWAY RIVER, NEW JERSEY.

In its original condition the Rahway River had a depth of 8 feet and more at mean high water from its mouth to Bricktown, 3⅝ miles; 7 feet at Edgar's Dock, 4½ miles; 4.4 feet to Milton Avenue Bridge, 4¾ miles; and 4 feet to Main Street Bridge, 5 miles, in the town of Rahway. Its commerce was estimated at 120,000 tons, and three attempts had been made to establish a line of steam-boats on the river, but had failed on account of the bad condition of the stream.

The original project for its improvement was adopted in 1878, and provided for dredging a channel 125 feet wide and 8 feet deep at high water from Bricktown to Milton Avenue Bridge, and 100 feet wide from that point to Main Street Bridge. The tide rises about 5 feet at the mouth and 4 feet at the head of navigation.

June 30, 1889, $36,992.70 had been expended under this project, which had resulted in the formation of a channel 7 feet deep at high water

and from 100 to 50 feet in width to within 550 feet of the head of navigation. It has not, however, proved permanent.

The commerce of the river had not increased, though freight rates to Rahway had been materially reduced as a result of the improvement of the river.

There has been no appropriation for this work since 1882, and the expenditures for the last fiscal year amounted to $7.30 for office expenses.

The condition of the river has deteriorated since the work was suspended and its commerce has decreased, the shoaling of the river having obliged one of the principal shippers to transfer his business to the railroad.

If it is the intention of Congress to complete this improvement, the balance of the estimate, $29,250, could be expended profitably as regards the efficient prosecution of the work during the fiscal year ending June 30, 1892, and would be applied to deepening and widening the channel by dredging.

The estimated amount required for the completion of the improvement in accordance with the approved project is $29,250.

This work is in the collection district of Perth Amboy, N. J., which is the nearest port of entry. The nearest light-house is Prince's Bay Light, and Fort Tompkins is the nearest fort.

Amount of revenue collected during the fiscal year ending June 30, 1890, $35,266.76.

Original estimate (1878)	$36,653
Revised estimate (1882)	66,250
Amount appropriated	37,000
Amount expended	37,000

Money statement.

July 1, 1889, amount available	$7.30
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	7.30
Amount (estimated) required for completion of existing project	29,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	29,250.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

In regard to the commerce of the Rahway River the following letter, which contains all the obtainable information, is self explanatory:

RAHWAY, N. J., *June* 9, 1890.

DEAR SIR: In reply to yours of May 5, in relation to Rahway River commerce, I would say, that about half a million of brick to George M. Friese was all the freight that passed up the river last year. Our coal has all to be brought by rail, boat-owners absolutely declining to traverse the stream. The narrow cut which was made some years ago would be of inestimable value were it finished to the width which I suppose it was intended to make it, but as it is now it is comparatively worthless, not being of sufficient width for a tug-boat to turn in.

Yours, very respectfully,

JOS. M. POTTER.

Capt. THOS. L. CASEY.

F 9.

IMPROVEMENT OF RARITAN RIVER, NEW JERSEY.

Before its improvement by the United States the Raritan River had a depth of 8.5 feet at "The Stakes," 3 miles; of 6.5 feet at the "Middle Grounds," 4½ miles; of 7.5 feet at Whitehead's Sand Dock, 8½ miles; and between this point and New Brunswick, 12¼ miles above the mouth, the channel was obstructed by a number of rocky shoals with depths of from 8.4 feet to 6.9 feet at mean low water. The City of New Brunswick and the Delaware and Raritan Canal, which terminates here, together with extensive brick-yards on the South River, had an extensive commerce on the stream, estimated in 1871 at 3,053,857 tons per annum.

The present project was adopted in 1874, and provides for obtaining, by diking and dredging, and, where necessary, by drilling and blasting rock, a channel 200 feet wide and 10 feet deep at mean low water, from the mouth to New Brunswick, at a cost of $2,093,662.05. It was modified in 1881, pursuant to the river and harbor act of that year, by adding to it the dredging of the south channel, about 13,000 feet long, 100 feet wide, and 5½ feet deep at mean low water, from Kearney's Dock to Crab Island.

Under this project $492,350.80 had been expended June 30, 1889, in constructing the dikes required by the project at "The Stakes" and "Middle Grounds," in dredging channels 200 feet wide and 12 feet deep at mean low water at these points, in drilling, blasting, and dredging a channel of the same dimensions across the rocky shoals at Whitehead's Sand Dock, and in carrying the channel still farther up the river to a point opposite Martin's Dock, under agreement with Mr. M. H. Flannery. Under the two special allotments made for it in the acts of March 3, 1881, and August 2, 1882, the south channel was dredged to the required depth for a distance of 4,000 feet. These improvements had been of great benefit to navigation, permitting the large tows in use on the river to reach a point 4 miles below New Brunswick at all stages of the tide. The commerce of the river was reported in 1887 at 1,675,355 tons, valued at $28,119,173, and in 1889 at 1,651,464 tons, valued at $25,507,194.

The gradual falling off in the commerce, from the much larger figure given above for 1871, is due to the purchase and partial disuse of the Delaware and Raritan Canal by the Pennsylvania Railroad.

The channel had been regulated and deepened from the mouth to Martin's Dock by public contracts and private agreements, when the Government dredging plant, described in the Annual Report for 1889, was completed and began operations on the river. This plant has continued to give great satisfaction, and, by the table given at the end of the present report, it will be seen that considerable saving has been effected.

The channel was extended from Martin's Dock with a width of 100 feet and depth of 10 feet at mean low water for a distance of 2,732 feet, carrying it to a point nearly opposite Mutton Gully, where work was suspended for the season, December 1, 1889, after a removal of 31,645 cubic yards. This material was deposited at Dike C, and subsequently thrown up by the dredge in such a manner as to form a training dike, as indicated in the Annual Report for 1889. It was found impracticable, however, to secure any coincidence in the times of finishing the bank and the arrival of the stone contractor's scows with riprap for

protecting it, so that a considerable amount of material would, on each occasion, be carried into the bed of the stream from the soft unprotected spoil-bank while waiting for the stone. Surveys of the river-bed in the vicinity of the dike showed a progressive deterioration from this cause, to such an extent that I was forced to abandon this method of disposal of the material.

On beginning operations the present season, April 14, 1890, with the plant considerably improved by an expenditure of $1,551.13 in affixing steel teeth to the dipper,* felting the boilers, renewing the dipper handle, etc., the principal problem to be solved was the disposal of the dredged material. Permission was obtained March 4, 1890, to employ a centrifugal sand pump on a ten days' trial, the object being to throw the material over Dike A; the pump would not begin to do the work, however, the plates of shale seriously interfering with its action, and the experiment was abandoned. Since this time the material has been deposited on the flats behind Dike 2, at high water, the loaded scows being maneuvered by a shallow-draught tug, hired for the purpose at $15 per day.

This method at first met with obstinate resistance on the part of a few people owning property on the southern shore, about 2,000 feet distant, their opposition being based on a fear that the spreading material would fill up their channel and that the presence of mud heaps on the flats would destroy the duck and snipe hunting. These fears have been allayed, however, and work has since progressed harmoniously and at a very great reduction in cost.

During the present season the 10-foot channel has been carried 740 feet farther, with a width however of 100 feet, it being considered preferable to obtain a navigable channel through the rocky portion, where progress is necessarily slow, as soon as possible, the intention being to subsequently widen it to 200 feet. A channel 80 feet wide, 570 feet long and 10 feet deep was also excavated, May 22 to June 12, near Fox's Gully on complaint of several of the interested citizens of New Brunswick that their vessels continually grounded at this point; after finishing this, regular work was resumed. The total number of cubic yards removed during the present season was 20,569, and the total for the fiscal year 52,214. The following table will show details of cost and other items of interest:

* In many places toward the close of the last working season the full depth of 10 feet could not be obtained, owing to an underlying bed of decomposing shale rock. From borings taken between this point and New Brunswick this shale appears to extend throughout; it is thinly laminated and full of joints and cracks, the strata dipping at an angle of about 25 degrees; it is readily torn apart by the heavy steel teeth of the dipper. It was soon apparent, however, that the excessive strains brought on the dredge in this way threatened serious damage, and permission was therefore obtained to have a smaller very strongly constructed dipper and handle made for the purpose of tearing up the shale, but at the close of the year this auxiliary dipper had not been delivered.

Detailed statement.

Month.	Total number of working days.	Actual time (days).			Average amount dredged per actual working day.	Total amount dredged and deposited.	Expenses.		Total cost of dredging and depositing per cubic yard.	Total cost per cubic yard including interest on original cost of plant.*	Remarks.
		Working.	Rehandling.	Lost.			Operating including maintenance while idle.	Repairs and additions.			
1889.					*Cu. yds.*	*Cu. yds.*					
May	11	8½	....	2½	441	3,750	$417.50	$137.81	$0.148	$0.162	Shrewsbury River, New Jersey.
June	25	19½	...	5½	420	8,195	1,244.42	405.07	0.201	0.219	Do.
July	26	20	...	6	373	7,455	1,714.32	67.67	0.239	0.259	Do.
August	26	16½	...	9½	422	6,960	1,309.36	443.77	0.252	0.273	Shrewsbury and Raritan rivers.
September	25	17	4	4	620	10,550	1,364.50	35.36	0.133	0.147	Raritan River.
October	27	18	7	2	537	9,655	1,196.70	243.39	0.149	0.165	Do.
November	24	17½	6	½	528	9,240	1,240.59	5.21	0.135	0.151	Do.
December	25	....	...	25	.....	.....	335.46	.....	.....	.....	
1890.											
January	26	....	...	26	.....	.....	145.00	.....	.....	.....	
February	23	....	...	23	.....	.....	145.00	87.33	.....	.....	
March	26	....	...	26	.....	.....	153.67	956.62	.....	.....	
April	26	11	...	15	264	2,899	420.19	449.87	0.30	0.319	Raritan River.
May	26	13	6	7	494	6,425	1,262.99	90.50	0.21	0.235	Do.
June	25	21	....	4	535	11,245	1,656.66	33.66	0.15	0.164	Do.
Totals and averages.	341	162	23	156	471	76,874†	12,606.36	2,956.26	0.204	0.23	
							15,562.62				

*Interest computed at 4 per cent.

†(1) 24160 cubic yards of which was removed from Shrewsbury River at a total cost of $4,469.29

The mean of prices paid contractors per cubic yard, from 1880–1883, for work done at same locality and of similar character was 35 cents per cubic yard, and the total cost at contractors' prices was therefore 8,456.00

Saving $3,986.71

(2) 52214 cubic yards of the above amount was removed from Raritan River at a total cost of 11,093.33

The lowest contractor's bid received in 1887 for work to be done in this locality and of similar character was for sand and gravel 43 cents per cubic yard, for shale and rock $3.50 per cubic yard (see annual report 1888). The material removed consisted of shale rock and coarse sand in about equal parts; assuming, therefore, a mean of these prices ($1.96) to represent the contract cost the price amounts to 102,339.44

Saving on Raritan River 91,246.11

Total saving (net) 95,232.82

The expenditures during the fiscal year amount to $18,334.59, as follows:

Cost of dredging (including expenses of operating and repairs to plant	$10,775.80
Cost of 668 cubic yards of riprap for Dike C	756.57
Cost of placing dredging and drilling plant in winter quarters and maintenance while idle	779.13
Cost of repairs to drill-scow	1,324.26
Cost of repairs to steamer *Star*	276.78
Cost of examinations and surveys	1,043.57
Cost of draughting	310.83
Cost of inspection	1,460.89
Cost of administration	1,606.76
Total	18,334.59

The amount that can be expended profitably as regards the efficient prosecution of the work during the fiscal year ending June 30, 1892, is $100,000, and if appropriated will be expended in carrying the improved channel farther up the river toward New Brunswick.

This work is in the collection district of Perth Amboy, N. J., which is the nearest port of entry; nearest light-house, Great Beds Light, in Raritan Bay; nearest fort, fort at Sandy Hook, New Jersey.

Amount of revenue collected at the port of Perth Amboy during the fiscal year ending June 30, 1890, $35,266.76.

Original estimate	$2,093,662.05
Amount appropriated	521,250.00
Amount expended	510,685.39

Money statement.

July 1, 1889, amount available		$27,713.59
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$17,148.98	
July 1, 1890, outstanding liabilities	1,424.27	
		18,573.25
July 1, 1890, balance available		9,140.34
Amount appropriated by act of September 19, 1890		50,000.00
Amount available for fiscal year ending June 30, 1891		59,140.34
Amount (estimated) required for completion of existing project		1,522,412.05
Amount that can be profitably expended in fiscal year ending June 30, 1892		100,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

The following statistics relative to the commerce of the Raritan River, New Jersey, during the year 1889, were compiled from statements furnished by parties doing business on the river:

Articles.	Amount.	Value.	Vessels.	No.	Average draught.	Average tonnage.
	Tons.				*Feet.*	
Coal	640,065	$2,469,304	Steam	1,654	7	238
Building material	556,220	3,165,580	Sail	3,720	6½	75
Iron and ores	140,776	3,740,500	Barges	6,678	6½	150
Miscellaneous	314,403	16,131,720	Rafts	220	1	150
Total	1,651,464	25,507,104		12,272		

Thirteen thousand one hundred and fifty-eight vessels passed through the draw at the mouth of the river during the year 1889.

F 10.

IMPROVEMENT OF SOUTH RIVER, NEW JERSEY.

Before the improvement of this stream was undertaken by the United States, the navigation of the lower 2½ miles of its course had been abandoned, and a canal dredged at private expense from a short distance below Washington to Sayreville, on the Raritan River. In 1880, when

the present project for improving the river was adopted, the mouth of this canal, on account of its faulty location, had shoaled to a depth of 6.4 feet at mean low water, and the best depth in the canal, some distance above, had decreased to 3.3 feet. Above Washington a depth of 2.7 feet existed to Bissett's, 3⅝ miles, and 2.5 feet to Old Bridge, the head of navigation, 6¼ miles above the mouth of the canal at Sayreville. The range of the tide was 5.3 feet at Sayreville. The town of Washington and numerous brick-yards did a commerce on the river valued at $1,249,000.

The present project, adopted in 1880, provides for closing the river below the head of the canal, correcting the direction of the mouth of the latter, and obtaining, by diking and dredging, a depth of 8 feet mean low water to Washington, 6 feet to Bissett's, and 4 feet to Old Bridge, straightening the channel at two points by cutting across the meadow. It is estimated to cost $194,695.

The amount expended under this project to June 30, 1889, was $63,468.09, with which the direction of the mouth of the canal had been changed, the dikes below Washington completed, and a small amount of dredging done on a shoal above Washington. No increase in the commerce of the river had been observed. Of the amount given above, $2,169.50 was contributed by this improvement as its quota of the price of a complete dredging plant for use in this district, the total cost of which was $44,690.

No active work has been done during the past fiscal year.

The bridge of the Raritan River Railroad Company across the South River has been the subject of bitter complaint on the part of James Bissett, who owns, or is considerably interested in, a brick-yard situated above the bridge in question, and who states that the draw is an obstruction to navigation. While this draw in its present location, with regard to shoals above and below it, seems to be somewhat difficult to pass for sailing vessels at certain stages of the wind and tide, it does not appear to be a sufficiently great obstacle to warrant the total interruption of passenger and freight traffic of the railroad, and a compromise plan has therefore been adopted. This plan, which was approved by the Secretary of War August 19, 1889, provides for the removal of the shoals immediately above and below, which have hindered free access to the draw, at a total cost of $850. No work has yet been done, however, as the smallness of the amount will not allow of any satisfactory arrangement with private parties for doing the dredging, and, as no further complaints have been received, it is proposed to allow it to remain until it can be included as a part of the general scheme of improvement under increased appropriation.

An examination of the river from its mouth to the Raritan River railroad bridge, completed June 30, 1889, showed that up to that time its physical condition had apparently undergone but slight change.

The expenditures during the fiscal year amount to $558.33, as follows:

Cost of examination of river from town of Washington to Raritan River Railroad Company's Bridge	$252.33
Cost of administration	306.00
Total	558.33

The sum of $30,000 can be expended profitably as regards the efficient prosecution of the work during the fiscal year ending June 30, 1892. It would be applied to giving the channel the full dimensions required by the project, below Washington, and extending the im-

provement to the brick-yards above; this would add greatly to the shipping facilities of the stream and would stimulate its increasing commerce.

The estimated amount required for the completion of the improvement is $128,695.

This work is in the collection district of Amboy. The nearest port of entry, Perth Amboy, N. J.; nearest light-house, Great Beds Light, in Raritan Bay, New Jersey; nearest fort, fort at Sandy Hook, New Jersey.

Amount of revenue collected at the port of Perth Amboy during the fiscal year ending June 30, 1890, $35,266.76.

Original estimate	$194,695.00
Amount appropriated	66,000.00
Amount expended	64,026.42

Money statement.

July 1, 1889, amount available	$2,254.25
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	280.67
July 1, 1890, balance available	1,973.58
Amount appropriated by act of September 19, 1890	5,000.00
Amount available for fiscal year ending June 30, 1891	6,973.58
Amount (estimated) required for completion of existing project	123,695.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	30,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

The following statistics relative to commerce of South River, New Jersey, during the past year were kindly furnished by Capt. Luther Adams, of the steamer *New Brunswick*, New Brunswick, N. J.:

Articles.	Amount.	Value.	Vessels.	No.	Average draught.	Average tonnage.
	Tons.				*Feet.*	
Building material	278,000	$664,930				
Posts, wood, etc	4,000	17,250	Sail	3,220	5½	45
Coal	16,350	73,900	Barges	1,216	7	120
Fertilizers	10,000	25,000				
Miscellaneous	1,800	154,000				
Total	310,350	935,080		4,436		

The above table shows an increase in the commerce of this stream of 81,171 tons over that reported in 1888.

F 11.

IMPROVEMENT OF SHREWSBURY RIVER, NEW JERSEY.

The project for this improvement was adopted in 1879, and contemplates the formation of a channel 6 feet deep at mean low water, and from 300 to 150 feet in width from the mouth of the river to Red Bank, on the North Branch, 8 miles, and to Branchport, on the South Branch, 9 miles.

In its original condition the river was much obstructed by sand-bars, on which the best depths at mean low water were: At the mouth, 3.9

feet; below Highland's Bridge, 5.4 feet; at Lower Rocky Point, 3.6 feet; at Barley Point, 3.3 feet; at Chalmer's, 5 feet; at Oceanic, 5.5 feet; below Belleview, 3.1 feet; at Seabright, 4.2 feet; at Jumping Point, 2.6 feet; at Sedge Island, 2.8 feet. A survey, completed in April, 1887, shows the depth at these points to be, 5.9 feet, 7.7 feet, 3.6 feet, 7.8 feet, 7.2 feet 4.5 feet, 5.9 feet, 4.4 feet, respectively. No changes are known to have taken place since.

The estimated cost of the existing project is $254,562, of which $210,233.45 had been expended June 30, 1889.

For more detailed information concerning the history of the dikes reference is made to the annual report on this improvement for 1889. These dikes are in fair condition, and have proved quite beneficial in maintaining the channel of the Lower North Branch, or Navesink.

The Shrewsbury River is a wide and shallow estuary, and was almost undoubtedly, at a time prior to the present subsidence of the coast-line, a comparatively deep valley, which has been filled from the sea, and has subsequently become shallow by deposits of material washed from the light sandy soil of the neighboring slopes. At present its bed consists of a fine loose sand, which is shifted, in considerable quantity, by each incoming and outgoing tide, and is in almost continual motion. The problems connected with the improvement of the river have therefore been somewhat difficult of solution, and nowhere is this difficulty more pronounced than at the Cross-over Channel, near Upper Rocky Point.

The Cross-over is a flood channel and has been dredged a number of times, but as it has always deteriorated, I think it is safe to say that it is impossible to maintain it under the present conditions. The ebb, which is a stronger and more important current than the flood, does not go through this channel, but sweeps across it and hugs the north shore, forming a deep channel, which is, however, choked at its lower end by an extensive flat, caused by the interference of the last of the ebb and the currents flowing in the South Branch, which are not synchronous with those of the North Branch.

In the project of July 13, 1887, a dike (M) was proposed, which was to be placed in the middle of the river at the western end of the shoal, separating the North (ebb) Channel and the South (flood) Channel, for the purpose of preventing the westward extension of the shoal. It will take but little study to show that the position of this dike (marked M on the map) is somewhat open to criticism, in that it still allows the ebb current to follow the north shore, and I have proposed as a substitute a spur-dike, shown in the accompanying map,* which is to extend for a distance of about 350 feet in the direction indicated, the object being to deflect a portion of the deep ebb current into the Cross-over.

As the effects of a spur-dike in a tidal estuary are always more or less problematic, it was recommended that this dike be of a temporary nature—of piles driven as close together as possible, breaking joints, cut off at or a little below mean low water and bound together with wire rope or otherwise secured. In case the position of the dike prove faulty the pipes to be drawn and disposed of, or on the other hand, if found by subsequent surveys to be of marked benefit, the temporary dike to be re-inforced by another similar row placed 12 feet behind it, the two bound together by heavy cross-timbers and the interval filled

* The cross-over channel is shown in this map as it existed at the close of the dredging operations of the past season. On going through this channel at low tide on June 18, 1890, in the *Sea Bird* (drawing about 4½ feet) we grounded lightly toward the lower end, showing that it has become much more shallow in spite of its use by side-wheel steamers.

with stone, the external sides being heavily riprapped at the same time. This modification of the project was approved June 16, 1890, and upon the appropriation of additional funds the dike will be begun without delay.

The channels are at present fairly good, the depths being about the same as those given in the last report; during the summer months they are maintained, in a navigable condition, by the passing steam-boats, but it is impossible to predict the position or extent of the bars which invariably form during the winter months.

The United States plant was employed on this improvement during the month of July and until the 17th day of August, 1889, when, the money being exhausted, the plant was removed to the Raritan River. The total number of cubic yards removed during the time above mentioned was 12,215,* at an average cost of 19.7 cents per cubic yard. The detailed statement of this work is included in the table given under the improvement of the Raritan River.

Whatever appropriation may be made by the next Congress will be expended in completing the dikes and dredging the shoals. The most economical results, in the prosecution of the work, can be obtained if the full amount required to complete the project be appropriated at once.

In addition to the steamers which regularly use the river a large number of small sailing vessels are engaged in the shipment of coal, lumber, sand, fish, and oysters.

The expenditures during the past fiscal year amounted to $4,059.43, as follows:

Cost of dredging by United States dredging plant	$3,224.00
Cost of inspection	344.39
Cost of examination of shoals dredged	$353.09
Cost of administration	137.95
Total	4,059.43

The amount necessary to complete the existing project is $40,062.

This river is in the collection district of Perth Amboy, which is the nearest port of entry; nearest light-house, Navesink Light; and nearest fort, fort at Sandy Hook, New Jersey.

Amount of revenue collected at the port of Perth Amboy during the fiscal year ending June 30, 1890, $35,266.76.

Original estimate (revised 1887)	$254,562.00
Amount appropriated	214,500.00
Amount expended	214,292.88

Money statement.

July 1, 1889, amount available	$3,267.83
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	3,060.71
July 1, 1890, balance available	207.12
Amount appropriated by act of September 19, 1890	10,000.00
Amount available for fiscal year ending June 30, 1891	10,207.12
Amount (estimated) required for completion of existing project	30,062.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	30,062.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

*The total number of yards removed by the United States dredging plant on the Shrewsbury was 24,160, at an average cost of 18.5 cents per cubic yard. The material was not rehandled and consisted of fine heavy sand.

Sou
of
ex
to
ire

COMMERCIAL STATISTICS.

The following statistics relative to commerce of Shrewsbury River, New Jersey, during the year 1889, were kindly furnished by Capt. James S. Throckmorton, Red Bank, N. J.:

Articles.	Amount.	Value.	Vessels.	No.	Average draught.	Average tonnage.
	Tons.				*Feet.*	
Fertilizers	50,000	$350,000	Steam	10	4½	350
Coal	70,000	240,000	Sail	20	3	25
Oysters and fish	5,000	505,000	Barges	10	3	25
Produce	150,000	1,400,000	Rafts	10	1	60
Miscellaneous	251,000	2,015,000				
Total	526,000	4,510,000		50		

It is estimated that the commerce has increased about 2,350 tons over that reported in 1887.

F 12.

IMPROVEMENT OF KEYPORT HARBOR, NEW JERSEY.

Keyport Harbor was originally accessible at low water only to vessels drawing less than 4 feet. Before its improvement was undertaken by the United States a 6-foot channel had been dredged at private expense, which had shoaled in 1872 to 5½ feet, and in 1882 to 5 feet, the range of the tide being 4.7 feet. A large commerce was carried on, however, valued at $2,932,000.

The project for the improvement was adopted in 1873, and provided for dredging a channel 4,700 feet long, 8 feet deep at mean low water, and 200 feet wide from the steam-boat dock to the 8-foot contour in Raritan Bay, at an estimated cost of $30,475.

The amount expended under this project to June 30, 1889, was $30,333.72, with which a channel had been dredged from the 8-foot curve in Raritan Bay to Keyport Wharf, a distance of 5,000 feet, with a width of 200 feet for the first 4,200 feet, and 160 feet for the remainder.

The commerce of the harbor had increased greatly, being estimated at $5,000,000, besides 150,000 passengers carried annually.

There has been no appropriation for this work since 1882, and the expenditures for the last fiscal year amounted to $141.28 for office expenses.

The dredged channel is stated to have shoaled in places to about 6 feet mean low water, but it is reported that the commerce as yet shows no falling off.

If it is the intention of Congress to complete this improvement, the balance of the estimate, $10,000, can be expended profitably as regards the efficient prosecution of the work during the fiscal year ending June 30, 1892, and would be applied to dredging the channel to the dimensions required by the project, which would add materially to existing facilities.

The estimated amount required for the completion of the improvement is $10,000.

This work is in the collection district of Perth Amboy, N. J., which is the nearest port of entry. Nearest light-house, Great Beds Light, in Raritan Bay; nearest fort, fort at Sandy Hook, New Jersey.

Amount of revenue collected at the port of Perth Amboy during the fiscal year ending June 30, 1889, $35,266.76.

Original estimate (1873)	$30,475
Revised estimate (1884)	40,475
Amount appropriated	30,475
Amount expended	30,475

Money statement.

July 1, 1889, amount available	$71.68
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	71.68
Amount (estimated) required for completion of existing project	10,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	10,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

The following statistics relative to commerce of Keyport Harbor, New Jersey, during the year 1889, were compiled from statements furnished by parties making shipments over this water-way:

Articles.	Amount.	Value.	Vessels.	No.	Average draught.	Average tonnage.
	Tons.				*Feet.*	
Building material	56,500	$175,000	Steam	12	6	475
Produce	54,775	1,969,375	Sail	70	5	100
Coal	1,000	5,000	Barges	62	6	200
Manure	20,000	40,000	Rafts	2	.....	.....
Miscellaneous	36,867	2,830,700				
Total	169,142	5,020,075		146	.....	.....

The estimated increase in tons over that reported in 1889 is about 1,000.

APPENDIX G.

IMPROVEMENT OF DELAWARE AND SCHUYLKILL RIVERS, AND OF RIVERS IN NEW JERSEY—HARBOR IMPROVEMENTS IN DELAWARE RIVER AND BAY—CONSTRUCTION OF PIER AT LEWES—DELAWARE BREAKWATER.

REPORT OF MAJOR C. W. RAYMOND, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1890, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Delaware River, Pennsylvania and New Jersey.
2. Harbor between Philadelphia, Pennsylvania, and Camden, New Jersey.
3. Schuylkill River, Pennsylvania.
4. Ice-harbor at Marcus Hook, Pennsylvania.
5. Ice-harbor at the head of Delaware Bay, Delaware.
6. Construction of iron pier in Delaware Bay, near Lewes, Delaware.
7. Harbor at Delaware Breakwater, Delaware.
8. Mantua Creek, New Jersey.
9. Removal of wrecks from Delaware Bay and River.
10. Removing sunken vessels or craft obstructing or endangering navigation.

EXAMINATION AND SURVEY.

11. Alloway Creek, New Jersey.

UNITED STATES ENGINEER OFFICE,
Philadelphia, Pa., July 9, 1890.

GENERAL: I have the honor to transmit herewith the annual reports for the works of river and harbor improvement in my charge for the fiscal year ending June 30, 1890.

I relieved Lieut. Col. Henry M. Robert, Corps of Engineers, of the charge of these works on February 13, 1890, in accordance with Special Orders No. 27, Headquarters of the Army, Adjutant-General's Office, February 1, 1890.

Very respectfully, your obedient servant,

C. W. RAYMOND,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

G 1.

IMPROVEMENT OF DELAWARE RIVER, PENNSYLVANIA AND NEW JERSEY.

The river and harbor act of August 11, 1888, contained an appropriation of $250,000 for improving Delaware River, Pennsylvania and New Jersey, of which $10,000 was to be expended upon the river and its tidal tributaries between Cooper's Creek and Trenton, N. J.

At the beginning of the fiscal year a balance of $183,122.20, exclusive of outstanding liabilities, but inclusive of amount covered by existing contracts, was available from the appropriation of August 5, 1886.

The expenditures made during the past fiscal year have been in furtherance of the approved project based upon the recommendations of the Board of Engineers of 1884, for "the permanent improvement of Delaware River and Bay," and have been applied toward the following operations:

1. A study of the data previously obtained from tidal and current observations made at points between the upper end of Petty's Island and Delaware Bay to determine the duration, direction, and velocity of the flood and ebb tides.
2. Examinations at Five Mile Bar, Port Richmond, Smith's Island Bar, Greenwich Shoal, Mifflin Bar, Schooner Ledge, and Bulkhead Shoal to determine the extent of works to be projected for their improvement or the action of works already in progress.
3. Improvement of the channel across Kinkora Bar.
4. Extension of dike between Fisher's Point and Petty's Island for the improvement of Five Mile Bar.
5. Extension of the main ship-channel near Port Richmond by dredging.
6. Rock removal from the main ship-channel near the foot of Otis street in the city of Philadelphia.
7. Improvement of Bulkhead Bar.
8. Extension of dike below the lower end of Reedy Island for the improvement of Dan Baker Shoal.

These operations will be treated in the above order, except that examinations where works are in progress will be considered in connection with those improvements.

The general project for the improvement of the Delaware River below Philadelphia contemplates the formation of a continuous channel 600 feet wide and 26 feet deep at mean low water. As the result of works already executed, there now exists from Philadelphia to Bulkhead Shoal, a distance of 36 miles, a channel from 200 to 300 feet wide and from 24 to 26 feet deep at mean low water. From Bulkhead Shoal to deep water at the head of the bay, a distance of about 20 miles, the channel is obstructed at three points, Bulkhead, Dan Baker, and Bombay Hook Shoals, where there are areas carrying from 20 to 21 feet at mean low water.

Vessels of large draught must pass all these shoals at a high stage of the tide. In descending the river they can not now do this in a single tide, for if they pass Bulkhead Shoal at high water they will reach Bombay Hook, at the other end of the encumbered reach, when the water has fallen about 3 feet. In ascending the river this difficulty is not so serious, for the vessels travel in the direction of the rising tide. It is evident, however, that no gain in time would result from the improvement of an intermediate point such as Dan Baker Shoal, while the extent and cost of the works and the time necessary for their exe-

cution are much greater than is required for the improvement at Bulkhead Shoal. For these reasons it appears to be for the best interest of commerce to next undertake the improvement of Bulkhead Shoal.

1. STUDY OF TIDAL AND CURRENT DATA.

The investigations based upon the tidal and current data, referred to in the last Annual Report, have been continued.

2. EXAMINATIONS OF THE RIVER AT VARIOUS LOCALITIES.

Smith's Island Bar and Shoal.—An examination of the channel between the revetments across the lower end of Smith's Island Bar shows that there has been a slight improvement in the widths and depths over those existing a year ago. The channel at its narrowest part now carries a depth of 6 feet at low water for a width of 125 feet, and a depth of 8 feet for a width of 60 feet; along the center line of these widths a minimum depth of 10 feet exists. Nothing has been expended upon this work since August, 1887.

An examination of the shoal extending above Smith's Island shows that between November, 1887, and December, 1889, the 6, 12, 18, and 24 foot curves of that part of the shoal lying between the prolongation of Arch and Callowhill streets has moved from 50 to 150 feet further away from the Philadelphia front and towards the Camden shore. A similar shifting of the shoal had been detected previous to 1887. Its later movement is to be accounted for by the action of the Fisher's Point Dike, whereby an increased ebb current is thrown into the Pennsylvania channel, thereby increasing the intensity and action of this current against the westerly side of Smith's Island Shoal. The slightly improved condition of the channel across the lower end of the bar, which has been previously described, is probably due to the same cause.

From these indications it seems fair to assume that with the removal of the lower part of Petty's Island, as proposed in the project for the improvement of Philadelphia Harbor, the erosive action of the ebb currents upon Smith's Island Shoal will be still further intensified.

Greenwich Shoal.—This shoal is situated about 3 miles below the foot of Market street, Philadelphia, and nearly opposite Gloucester, N. J. The examination was induced by the statements of pilots and others, that obstructions existed in the main ship-channel passing to the west of the shoal.

It is found that the main shoal and adjacent channels remain unchanged except at one point in the west channel about 600 feet below the coal wharves, where a small shoal area, with a least depth of 23 feet at mean low water, projects into the main ship-channel so as to reduce its width to about 250 feet. This shoal, besides being an obstruction to navigation, interferes with access to important coal wharves.

Mifflin Bar.—The examinations made at this locality were to determine the action of the dike built for the improvement of this bar. The dike is about 7,200 feet in length, extending from the Pennsylvania shore at Hog Island to Marden Island. It consists of a random stone enrockment upon a brush mattress foundation. The object of the dike is the improvement of the main ship-channel over Mifflin Bar by the concentration of the tidal currents thereon. The dike was commenced in 1885, and completed to the height of mean low water in September, 1888. Since that date no additions have been made to the work.

Frequent examinations were made during the progress of the dike, but they failed to indicate any effect upon the bar until in September,

1888, when it became evident that a small increase in the depth of water on the crest of the bar had occurred.

To test the capacity of the dike to maintain an increased depth on the bar a channel about 250 feet wide, with a least depth of 26 feet on its sides and 28 feet in the middle, was dredged across the bar during the months of October and November, 1888. A survey of the dredged channel was made in December, 1888, three weeks after the completion of the dredging, and re-examination made in May, 1889, December, 1889, and May, 1890. From a comparison of these surveys the following results are obtained: The mean of all depths found in the dredged channel 250 feet wide and 4,000 feet long were as follows: In December, 1888, 27.5 feet; in May, 1889, 27.2 feet; in December, 1889, 26.3 feet; and in May, 1890, 25.6 feet at mean low water.

The most marked effect of the dike is a general increase in depths, due to ebb-tide action, of from 1 to 3 feet over an area about 1,200 feet wide and 8,000 feet long adjacent to and parallel with the dike. Since the main ship-channel does not fall within this area it is evident that this increase in depth and consequent increase in cross-section of the river outside of the main ship-channel is unfavorable to the channel across the bar, for as shown by comparative examinations this deepening in the vicinity of the dike is accompanied by a loss of channel depths.

At the close of the last fiscal year the channel across the bar carried a depth of 24 feet for a width of 250 feet and a depth of 26 feet at mean low water for a width of 150 feet. At the present time the same widths and channel depths exist, although the mean depths over the whole area have decreased.

It is quite certain that a channel 600 feet wide and 26 feet deep, as contemplated in the general project, can not be maintained by the dike with its present dimensions. Ultimately the upper half of the dike should be raised to 2 feet above high water, as has been done with the Fisher's Point Dike. But it is probable that the dike as at present constructed will maintain enough water in this channel for practical purposes until other points below Mifflin Bar, which are more marked obstructions to navigation, have been improved. In the mean time, through the aid of frequent examinations, trustworthy conclusions can be reached as to the ultimate action of the dike and the extent to which such action may require to be increased. Maiden Island, upon which the lower end of the dike abuts, begins to indicate the increased action of the ebb, which is thrown against its upper end, by the cutting away of its shore-lines. Should this continue, it may be necessary to protect the upper end of the island by revetment.

Schooner Ledge.—A survey of about 6 miles of the river has been in progress at and below Schooner Ledge for the purpose of determining whether the improvement of the main ship-channel passing the ledge can be accomplished on a line involving the removal of less rock than hitherto proposed. The results obtained indicate a high probability that by a re-adjustment of the range lines a channel 600 feet wide and 26 feet deep at mean low water can be obtained in this part of the river at a cost much less than previously estimated. To establish the correctness of this inference additional work is yet required in the way of borings and sweeping the bottom for the detection of isolated points of rock.

The examinations made at Five Mile Bar, Port Richmond, and Bulkhead Bar will be considered in connection with these localities under constructive operation.

3. IMPROVEMENT OF KINKORA BAR.

This locality is situated about 25 miles above the foot of Market street, Philadelphia. In its improved condition Kinkora Bar carries a ruling depth of 7½ feet at mean low water, and forms the only obstruction to a 12-foot low-water channel as far up river as Whitehill.

Under date of February 13, 1890, Lieut. Col. Henry M. Robert, then in charge of this district, submitted to the Chief of Engineers a project for the improvement of this locality. The project was approved February 28, 1890, and proposed the formation of a 12-foot low-water channel across the bar by the aid of a dike, partly closing the slough south of Newbold's Island, supplemented by dredging on the line of the proposed channel.

The dike was to consist of an earthen embankment about 200 feet in length, faced with stone, and extending from high to low water mark; from thence a pile and stone dike 600 feet in length, extending to within about 100 feet of the wharf upon the southern side of the slough; the the dikes to be raised to about 2 feet above mean high water.

The amount available for this was about $15,000, derived from the appropriations of 1886–1888.

Under date of April 24, 1890, a contract was entered into with William T. Gaynor for the construction of 600 linear feet of pile and stone dike. At the close of the fiscal year 600 linear feet of the dike was in process of construction.

During the present season it is proposed, in addition to the 600 feet of pile and stone dike, to construct the 200 linear feet of earthern embankment, faced with stone, and to dredge a channel across the bar 100 feet wide and 12 feet deep at mean low water.

With this improvement of Kinkora Bar accomplished, it is not considered that the present requirements of commerce will justify further improvement of that part of the river lying above Philadelphia.

4. DIKE BETWEEN FISHER'S POINT AND PETTY'S ISLAND (FIVE MILE BAR).

At the end of June, 1889, a dike had been built from Fisher's Point towards Petty's Island for a distance of 3,000 feet, and to the height of mean low water, together with 500 feet additional of mattress-sill. The object of this dike was the improvement of the channel across Five Mile Bar, as proposed in the project of the Board of Engineers of 1884, and the above amount of dike extension was covered by the estimates of the Board.

After the completion of the dike to the above length frequent examinations and local surveys were made of Five Mile Bar, to determine the extent of the dike's action toward the improvement of the bar. From these comparative examinations the following conclusions were reached: (1) The effect of the dike had been to lower the crest of the bar about 4 feet throughout a distance of about 2,000 feet. (2) The maximum effect of the dike was reached in 1886 or 1887, after which time no appreciable change of depth had taken place on the bar crest. (3) The best channel across the bar on June 30, 1889, was about 8 feet at mean low water for a width of about 200 feet.

With the lapse of time, and in the light of still further examinations of the action of the dike as completed in 1886, it became a settled conviction that a sufficient channel across the bar could not be obtained without largely increasing the tidal flow over the bar, and that this

could only be accomplished by diverting from the New Jersey channel back of Petty's Island a still larger volume of the tide and concentrating it upon Five Mile Bar.

In September, 1888, it was decided to raise the entire 3,500 linear feet of dike to a height of 8 feet above mean low water, and to still further increase its action by extending the dike at this height for an additional distance of 1,000 feet.

Under date of October 23, 1888, a contract was entered into with John A. Bouker for the work required upon the 3,500 linear feet of stone dike, and on October 28, 1888, and March 14, 1889, contracts were made with Messrs. Davis and Irvin for the construction of 1,000 linear feet of pile and stone dike. Work was in progress upon these contracts during the fiscal year ending June 30, 1889.

During the past fiscal year, under the contract with John A. Bouker, 10,773 cubic yards of stone were placed in the 3,500 linear feet of dike covered by his contract, thereby completing his contract on April 16, 1890, by the aggregate placing of 16,914 cubic yards of stone. Under the two contracts with Messrs. Davis and Irvin 1,000 linear feet of pile and stone dike were completed.

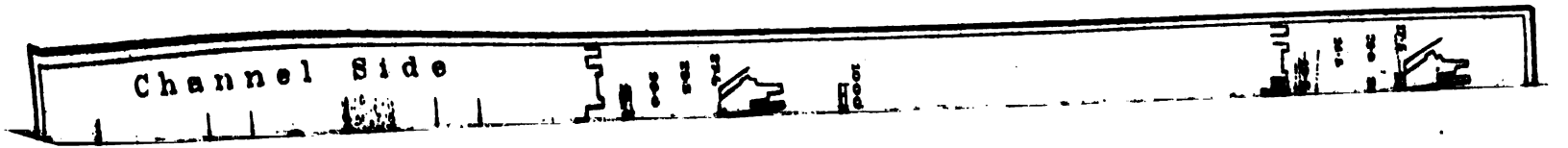
Under the several contracts which have been made for the extension and elevation of the dike since its commencement in 1885 there has been expended $83,282.43. About 142,000 cubic yards of gravel and bowlders dredged from the Main Ship-Channel at Port Richmond during 1888 and 1889 was utilized as a backing to the stone-dike and partly as filling for the pile and stone dike, and 1,178 yards of rock in place, removed from the channel near the foot of Otis street, was used as filling for the pile and stone dike.

An examination of Five Mile Bar, made at the close of the fiscal year, shows that a channel 11½ feet deep at mean low water exists across the bar for a width of about 500 feet. This increase in depth of from 8 feet in 1889 to 11½ feet in 1890 has followed directly from the additional length and height given to the dike between these dates.

With this channel depth of 11½ feet over Five Mile Bar it may be considered that the project of the Board of Engineers of 1884 for the improvement of this locality has been realized. The action of the dike in producing a concentration of both the flood and ebb currents in the Pennsylvania channel is very marked; with the former its action is seen in the increased force of the current upon the bar at the point of greatest deepening, in the up-river movement of the deep-water channel north of the bar, and in rolling the upper end of the bar to the south; with the ebb current the action of the dike is manifested by the prolongation of the deep-water channel adjacent to the dike, in the increased velocity of the current across the bar at the point of the greatest deepening, and in the rolling to the eastward of the upper end of Smith's Island Shoal, which is 4 miles below the dike.

The action of the dike upon the flood and ebb tide is illustrated by the results of a series of simultaneous observations made upon staff gauges placed on opposite sides of the dike at a point about 1,000 feet from the shore end of the dike. During the last three-fourths of the flood tide the gauge upon the south side of the dike read from 0.25 to 0.35 of a foot higher than the gauge upon the north side of the dike; while during the last half of the ebb tide the gauge upon the north side of the dike read from 0.15 to 0.25 of a foot higher than the gauge upon the south side of the dike.

The impounding of the flood tide in the area south of the dike produces an increased flood current through the interval between the lower


Channel Side

end of the dike and upper end of Petty's Island, which, joining with the flood tide passing up the Pennsylvania channel, results in a marked augmentation of the flood-current velocity over the bar. By the removal of a part of the lower end of Petty's Island, as now contemplated, the increased width given to the Pennsylvania channel at that point will more freely admit flood tide and thereby reduce the present impounding effect of the dike.

5. EXTENSION OF THE MAIN SHIP-CHANNEL NEAR PORT RICHMOND

The extension of this channel has been in progress since 1879, and has for its object the formation of a 26-foot low-water channel along the Philadelphia front, extending from the deep water below Port Richmond to a point about midway between the American Ship-building Company's Yard and the Gas Trust Wharf, or nearly opposite the upper end of Petty's Island.

The material removed by dredging in the formation of this channel consists of coarse gravel, mixed with bowlders, upon which the currents have but little disturbing effect. This characteristic, while somewhat increasing the cost of removal by dredging, renders the material very stable, and advantage has been taken of this fact since 1885 by placing the material dredged in the Fisher's Point Dike and Smith's Island Bar revetment as foundation filling and backing, instead of stone. In this manner 307,611 cubic yards have been utilized, of which 89,790 cubic yards were used during the past fiscal year.

Under date of February 9, 1889, an agreement was entered into with the American Dredging Company for the removal of about 120,000 cubic yards of material, at 20 cents per cubic yard, in the extension of this main ship-channel at Port Richmond. During the fiscal year 89,790 cubic yards were removed and deposited as backing to the Fisher's Point Dike. By this work a channel 26 feet deep and from 200 to 400 feet wide has been extended to a point about 2,000 feet above the Elevator Wharf.

6. ROCK REMOVAL NEAR THE FOOT OF OTIS STREET.

An examination of the river, made in November, 1888, developed the existence of the outcrop of a ledge of rock outside of the Port Warden's line and near the foot of Otis street, in the city of Philadelphia.

The least depth upon the rock at low water was about 17 feet, and the area of the ledge within its 26-foot contour and outside of the Port Warden's line was about 1,200 square yards. Extensive improvements to the wharf frontage directly inshore from this ledge were already in progress, which would have been seriously impaired by the presence of this rock.

Under date of December 12, 1888, a project was submitted for the removal of about 800 square yards of the ledge directly in front of the wharves in progress of construction to a depth of 26 feet at mean low water. This involved the removal of about 1,200 cubic yards of rock in place.

This project was approved December 26, 1888, and an agreement was entered into under date of January 23, 1889, with the American Dredging Company, for the removal of the rock and the placing of it in the pile-dike at Fisher's Point for $9 per cubic yard in place.

During the past fiscal year the work was completed by the removal

of 1,178.3 cubic yards of rock, measured in place and the placing of material as filling in the pile-dike at Fisher's Point.

A part of the ledge, covering about 400 square yards below the area from which the rock was removed, lies directly in front of Otis Street Wharf, from which the city of Philadelphia has projected, for a distance of 200 feet into the river, a water pipe which forms the intake of the Kensington pumping station. This pipe lies directly upon the surface of the rock and is covered with riprap stone, and any interference with it at the present time would be a serious inconvenience to the city.

7. IMPROVEMENT AT BULKHEAD SHOAL.

This shoal is about 36 miles below Philadelphia, or about 2 miles below New Castle, Del. In its natural condition it carries from 20 to 21 feet at mean low water. The channel has been repeatedly deepened by dredging since 1885, but the shoal soon returns to its original condition.

For the reasons previously stated, the improvement of this shoal is considered of immediate importance. The adopted project has been prepared after detailed investigations made in accordance with the recommendations of the Board of Engineers of 1884, and the progressive changes and physical characteristics of this locality have been ascertained from comparisons of the recent survey of 1888 with those of 1840–'41, 1861, 1873, and 1881. These comparisons clearly develop the evolution of the shoal and bar as they now exist. The results of the investigation are briefly as follows:

During the interval of about forty-eight years covered by the surveys the upper end of the shoal, which in 1840 occupied the position of the present bar, has moved steadily to the westward, and it is now about 3,000 feet west of its position in 1840. This change has been accompanied by a corresponding movement of the entire shoal, by a flexure of its axis about the upper end of Pea Patch Island. In 1840 the West or Delaware Channel was the main ship-channel and carried the best water. With the westward movement of the shoal since that time the eastern channel has been constantly improving and the western shoaling.

The flood-tide channel which lies along the eastern face of Bulkhead Shoal has followed its westward movement. The ebb-tide channel above the bar is slowly working its way down stream and more and more to the eastward, while the flood-tide channel below the bar is tending more and more to the westward. These changes are constantly increasing the width of the middle ground between the two channels. With the advance of the ebb-tide channel there has been, since 1881, a recession of 2,000 feet in the upper end of the flood-tide channel.

In the present movement of the ends of these channels there is no indication that they will effect a junction across the bar, but rather that they will move in paths still more divergent.

The locations of the lines of greatest intensity of the flood and ebb currents are shown on the accompanying tracing.

The bar being a middle ground between the paths of the ebb and flood tides, its improvement requires that these paths shall be made more nearly coincident. In the light of the recent surveys and current observations, the lines of approach to the bar of the flood and ebb tides seem too widely divergent for the accomplishment of the work by a single construction. The flood tide must be so controlled as to prevent any further westward movement of the upper end of its channel, while

D
DE

the ebb must be divided from its eastward movement and concentrated upon the shoal areas of the bar. It is believed that these objects can be best attained by the construction of two dikes located as shown on the accompanying sketch.

The location and extent of the dikes were determined (1) so as to deflect the currents on the bar and aid the concentration in establishing and maintaining the desired depth, (2) so as to check the hurtful changes now in progress, and (3) so as to connect the deep-water channels above and below the bar by a channel having a direction convenient for navigation.

The east dike starts from the New Jersey shore and passes obliquely across the eastern ebb channel, its object being to arrest the eastward movement of the channel and concentrate the ebb upon the bar. The west dike is situated upon the opposite side of the bar, with its upper end curving to the westward. Its middle and lower parts are intended to train the flood currents upon the bar and check the westward movement of the flood channel, while its upper end is designed to catch a part of the ebb current now passing down the Delaware channel, and thus add to the concentration of the ebb tide upon the bar produced by the east dike.

It is proposed to construct the east dike first, since it is considered most important to check the eastward movement of the ebb channel and concentrate the ebb currents on the bar. If the west dike were first constructed, the eastward movement of the channel would doubtless be increased. It is not only the lack of depth, but also this eastward movement of the channel, which renders navigation difficult, and no improvement seems possible until this movement is checked. If the movement was increased by the construction of the west dike before the east one, little or nothing would be gained even with an increase of depth. The construction of the east dike will check this movement, and, so far as it produces a deepening effect, will produce it in the right location. Considering the ebb current only, it seems almost as if the east dike might do the work alone, its tendency being not only to scour across the bar, but also to shoal up the westward channel. But the flood will be deflected by the east dike, and must be headed off sooner or later.

The west dike is to be subsequently constructed, beginning at the upper end, and it is to be extended down-stream until the desired results are attained. Its length, which can only be definitely determined by experience, is assumed at 6,800 feet. The combined projected length of the two dikes is 11,000 feet.

Experience at Five-Mile and Mifflin bars indicate the probability that the dikes generally will have to be brought to at least the level of high water in order to produce the desired results. At the first named locality the dike was constructed to the level of mean low water in 1885–'86; but in 1889 it had to be extended and raised about 8 feet in order to produce a depth of 12 feet over the bar. At Mifflin Bar the dike was completed to mean low water in 1888; and the evidence of recent surveys shows that it will be necessary to raise it at least to the level of mean high water in order to maintain the projected channel. It is therefore proposed to construct the dikes at Bulkhead Shoal to the level of high water.

Instead of the brush and random stone dikes formerly projected, pile and stone dikes have been adopted, as shown in plan and section on the accompanying sketch. This method of construction has been employed successfully in a portion of the Fisher's Point Dike for the improvement of Five-Mile Bar. It is much cheaper than a stone and

brush structure of the same height, the effects of scour are less serious and more easily remedied, and the stone is better protected from displacement by ice.

The width of the east dike is 11 feet for a distance of 1,400 feet from the shore end, over which the average high-water depth is 12 feet; the next 1,200 feet will have a width of 13 feet in water 18 feet deep, and for the remaining distance of 1,600 feet, over which the average high-water depth is 26 feet, the width is 15 feet.

The width of the west dike for a distance of 2,800 feet from its upper end is 15 feet, over which the average high-water depth is 23 feet; the next 2,000 feet has a width of 13 feet in a high-water depth of 20 feet; the remaining 2,000 feet has a width of 11 feet in a high-water depth of 18 feet.

The cost of the east dike is estimated at $110,000, and of the west dike $170,000.

The adopted project for the improvement of Bulkhead Bar was approved by the Chief of Engineers, May 15, 1890.

8. DIKE BELOW REEDY ISLAND.

The object of the works in progress at this locality since 1887 is the improvement of the main ship-channel just below Reedy Island, where it is obstructed by Dan Baker Shoal, which carries a depth of only 20 feet at mean low water. The improvement, as proposed by the Board of Engineers of 1884, is to be accomplished by a dike nearly 5 miles in length, extending from the lower end of Reedy Island to a point on the right bank of the river below the mouth of Blackbird Creek.

At the close of the fiscal year of 1889, 4,000 linear feet of dike had been built southward from the lower end of Reedy Island, and a commencement made upon the construction of a third section of 2,000 linear feet under a contract with E. H. Gaynor, dated October 24, 1888.

During the past fiscal year 20,452 cubic yards of brush-mattress and 10,397 cubic yards of stone were placed under this contract, completing work on December 16, 1889. Under this contract 22,756 cubic yards of brush-mattress and 11,412 cubic yards of stone were placed in the work.

The 4,000 linear feet of dike built previous to the past fiscal year consists essentially of a brush-mattress foundation about 1 foot in thickness, upon which is placed random stone up to the plane of mean low water, where it has a width of 5 feet. The width of the mattress varies from 25 to 35 feet, according to the depth of water. After reaching a distance of about 3,000 feet below Reedy Island the foundation became so yielding that narrow wing-mattresses were attached on each side of the main mattress sill projecting beyond it 8 feet on the shore (or Delaware) side and 12 feet on the channel side. The wing-mattresses were covered with only enough stone to cause them to sink with the main mattress and to follow with their outer edges any depression which might be produced by scour.

The action of this brush-mattress foundation in resisting undue settlement was fairly satisfactory with the weight imposed upon it; but when it was considered that possibly the dike might require in the future to be raised above the plane of mean low water to secure the desired effect upon the adjacent shoal areas, it was felt that provision should be made in the remaining part of the dike for relieving the soft bottom of the river from all possible weight due to that part of the structure below the plane of mean low water. To accomplish that object the 2,000 linear feet of dike completed during the last fiscal year consists of a foundation-

mattress 35 feet wide and 3 feet thick, upon which is placed 2 feet of stone followed by alternate mattresses 3 feet thick and covered with 2 feet of stone until the plane of low water is reached. The dike is built in water about 15 feet deep, and consequently consists of three superimposed mattresses separated from each other by 2 feet of stone. The upper mattress has a width of 25 feet, and after allowing for probable settlement and compression will be covered with from 5 to 6 feet of stone, having a top width of from 15 to 12 feet.

The contract price paid for the brush-mattress and stone are respectively $1.25 and $1.30 per cubic yard. The brush-mattresses are closely compressed in their construction, but, allowing for subsequent compression of one-third under the weight of stone imposed upon them, the reduction in weight resulting from their use reduce the weight imposed upon the bottom of the river to nearly one-half of what would result from an equivalent cross-section of stone.

The Delaware River is tributary to the following collection districts: Trenton, Philadelphia, Wilmington, and Bridgeton.

The amount of revenue collected in these districts during the year ending December 31, 1889, was $22,623,104.13.

Total amount appropriated for improvement of Delaware River from 1836 to June 30, 1890	$2,012,000.00
Total expenditures to June 30, 1890	1,942,941.78
Total amount appropriated on present project to June 30, 1890	660,000.00
Total expenditures on present project to June 30, 1890	590,941.78

The accompanying commercial statistics were furnished by the Philadelphia Board of Trade, Mr. F. W. Taylor, shipping and freight agent, Philadelphia and Reading Railroad Company, and Mr. C. L. Nicholson, secretary Chesapeake and Delaware Canal Company.

Earnest efforts have been made to collect full commercial statistics of the Delaware River, but the results are far from satisfactory. The statistics of foreign commerce were obtained without difficulty, but with regard to the coastwise commerce it was found impossible to procure accurate and complete information. No official public record is required of the cargoes of coastwise vessels, and the information can only be obtained from the private records of those interested in such commerce. Apart from the objection many have to the work of furnishing information covering a commerce probably exceeding in value $100,000,000, there is objection to making public information of a private character showing to rival interests the amount of business carried on between particular points by steam-ship companies.

These remarks are applicable to all other rivers and harbors in this district.

Money statement.

July 1, 1889, amount available		$100,058.87
July 1, 1889, amount covered by existing contracts		83,063.33
		183,122.20
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$114,063.98	
July 1, 1890, outstanding liabilities	115.95	
July 1, 1890, amount covered by uncompleted contracts made during fiscal year ending June 30, 1890	9,003.30	
		123,183.23
July 1, 1890, balance available		59,938.97
Amount appropriated by act of September 19, 1890		250,000.00
Amount available for fiscal year ending June 30, 1891		309,938.97

Amount (estimated) required for completion of existing project	$1,715,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	600,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for constructing a pile and stone dike in the Delaware River at Kiskora Bar, opened April 17, 1890, by Maj. C. W. Raymond, Corps of Engineers.

No.	Name and address of bidder.	Approximate quantities.						Amount.
		Delaware pine piles, 17,500 linear feet	White-oak piles, 560 linear feet.	Pine wales and angle blocks, 45,000 feet B. M.	Wrought-iron tie rods and screw bolts with washers, 10,500 pounds.	Drift bolts, 1,000 pounds.	Stone filling, 3,600 cubic yards.	
		Per lin. foot.	*Per lin. foot.*	*Per 1,000 feet B. M.*	*Per pound.*	*Per pound.*	*Per cu. yd.*	
1	William Henry Lownsbury, Philadelphia, Pa	$0.13½	$0.26½	$46.00	$0.4½	$0.3½	$1.62	$10,920.40
2	Davis & Irvin, Philadelphia, Pa	.15	.25	37.00	.3¾	.3	1.37½	8,777.50
3	Ira Lunt, New Castle, Del	.17	.27	37.75	.4	.3¾	1.40	10,322.45
4	Wm. T. Gaynor, Fayetteville, N. J.	.14	.23	33.50	.3	.3	1.27	9,003.30
5	Joseph S. Allen, Philadelphia, Pa	.17	.30	38.00	.4	.3½	1.59	11,032.00

Contract (dated April 24, 1890) entered into with William T. Gaynor. In progress.

COMMERCIAL STATISTICS.

PORT OF PHILADELPHIA.

Domestic and foreign entrances and clearances, 1889.

Class.	Entered from foreign ports.				Cleared for foreign ports.			
	With cargoes.		In ballast.		With cargoes.		In ballast.	
	No.	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*
American steam-vessels	19	38,513	1	55	21	40,618	2	456
American sail-vessels	366	185,360	9	13,631	230	138,063	4	1,549
Foreign steam-vessels	529	706,022	47	73,638	306	461,748	75	52,897
Foreign sail-vessels	285	178,765	44	43,427	309	211,504	7	2,797

Value of exports		$31,463,720
Value of imports:		
Free of duty	$4,983,702	
Subject to duty	46,013,100	
		50,996,802

Statement of revenue collections.

Year.	Received.	Increase for year.
1885	$13,915,553.66	$1,385,101.90
1886	16,303,918.77	2,388,365.11
1887	17,950,235.10	1,646,316.33
1888	20,567,684.17	2,617,449.07
1889	22,612,956.17	2,045,272.00

Coastwise entrances and clearances, 1889.

Class of vessels.	Entered.	Cleared.
Steamers	1,443	1,647
Ships	9	9
Barks	21	69
Brigs	8	29
Schooners	2,263	2,389
Total	3,744	4,143

Statement of vessel movement to and from Port Richmond piers, Delaware River front, for the year ending December 31, 1889.

Class.	Number.
Steamers	535
Sailing vessels	1,737
Canal-boats and barges	7,190
Total	9,462

Freight statement.

	Tons.
Received:	
Foreign iron ore	349,556
Miscellaneous	185,191
Total	534,747
Shipped:	
Pig-iron	38,872
Steel rails	63,774
Flour	35,074
Grain	92,000
Coal	1,700,000
Miscellaneous	162,825
Total	2,092,545

Statement of vessels passing through the Chesapeake and Delaware Canal to and from Delaware River, during the year ending December 31, 1889.

Class.	Arrivals.	Departures.
Steamers	851	865
Sailing vessels	1,015	1,202
Canal-boats and barges	1,475	1,390
Rafts	167	15
Total	3,508	3,470

Freight statement.

Articles.	To Delaware River.	From Delaware River.
	Tons.	*Tons.*
Coal	57,520	154,902
Cotton	1,059	508
Iron	4,581	10,224
Lumber	84,220	.....
General mercandise	228,145	72,852
Total	375,525	238,486

SPECIAL REPORT ON IMPROVEMENT OF DELAWARE RIVER BETWEEN BRIDESBURG, PENNSYLVANIA, AND TRENTON, NEW JERSEY.

UNITED STATES ENGINEER OFFICE,
Philadelphia, Pa., February 13, 1890.

GENERAL: I have the honor to submit the following report upon the Delaware River between Bridesburg, Pa., and Trenton, N. J.:

This report is made for the purpose of conforming to the recommendations of the Board of Engineers of 1885, so far as they relate to the river above Bridesburg, as set forth in the report of the Board under date of January 23, 1885.

Although the work was mainly accomplished by the close of the season 1886, it became evident that changes were in progress in the upper part of the river which required to be studied by comparative surveys and local examinations before safe conclusions could be reached. These studies have necessarily delayed the completion of this report until the present time.

The requirements of the Board are covered by the following:

(1) A line of levels between Five Mile Point and Trenton connecting with bench-marks at each station where improvements are required.

This line is the upper part of a continuous line of levels recommended by the Board to be run between Cape Henlopen, Delaware, and Trenton, N. J.

(2) The establishment of tidal stations, with necessary observations, at points between Bridesburg and Trenton.

(3) The detailed survey of the river between Bridesburg and Trenton.

(4) The gauging of the river above tidal influence near Trenton.

(5) An estimate of the extent of the bowlders in the steam boat channel just below Trenton.

(1) *Levels between Five Mile Point and Trenton.*—The line of levels of 1885 began at the Harrison bench-mark near Five Mile Point and extended to the railroad bridge crossing the Delaware River at Trenton, N. J., the distance between these points being about 29 miles. The Harrison bench-mark had previously been connected with the U. S. Coast and Geodetic Survey bench-mark at the League Island Navy Yard.

In 1882 a line of levels had been run between Five Mile Point and the Trenton Bridge, and the difference in the results when compared with the levels of 1885, was less than two-tenths of a foot.

Bench-marks were established between Five Mile Point and Trenton, at points convenient to the river, and permanent bench-marks made at all localities where further improvements might be required.

(2) *The establishment of tidal stations, with necessary observations, at points between Bridesburg and Trenton.*—To accomplish this, self-registering tide-gauges were established at Bridesburg, Burlington, Whitehill, and Trenton, and the zeros of the gauges were connected with the line of levels previously described. The following table gives the tidal elements as derived from these observations:

Station.	Elevation, mean high water.	Elevation, mean low water.	Range of tide.	Duration of flood.	Duration of ebb.	Establishment.
				h. m.	*h. m.*	*h. m.*
Bridesburg	106.23	100.25	5.98	4 52	7 33	14 21
Burlington	106.18	100.39	5.79	4 56	7 29	15 29
Whitehill	106.04	101.02	5.02	5 11	7 14	16 27
Trenton	106.50	102.38	4.12	4 22	8 03	16 46

The elevations given for mean high and mean low water refer to the datum plane of mean low water at the U. S. Coast and Geodetic standard gauge at the League Island Navy Yard, this datum plane being taken as 100,000.

(3) *Detailed survey of the river between Bridesburg, Pennsylvania, and Trenton, New Jersey.*—The length of the river between these points is about 28 miles. To properly connect this survey with the river below the survey under consideration was commenced at Five Mile Point or about 1 mile below Bridesburg. The results of the survey between Five Mile Point and Trenton are shown on five sheets transmitted herewith. At two localities, viz, Bordentown and Kinkora Bar, subsequent surveys were made, the results of which are shown on the sheets above alluded to.

The general facts relating to channel depths as derived from this survey will be considered under a subsequent heading referring to the improvement of the river between Philadelphia and Trenton.

(4) *Gauging the Delaware River above tidal influence near Trenton, New Jersey.*—This work was done in 1886, at a point about 3 miles above Trenton Rapids and entirely above tidal influence.

A gauge was maintained at the Yardley Bridge, just above the gauging station, during the entire year of 1886, and the readings of this gauge in connection with gaugings made furnished data for an approximate conclusion as to the varying fresh-water inflow during the year 1886. These observations show that the inflow from above Trenton varied from a minimum average of 2,300 cubic feet per second for the month of September to a maximum average of 22,000 cubic feet for the month of January, 1886. The mean inflow for the months of June, July, August, September, and October, during which interval the river was free from freshets, was 3,300 cubic feet per second, while the mean for the remaining months of November, December, January, February, March, April, and May, when the river was more or less in freshet, was 12,500 cubic feet per second.

By comparing the inflow during the months in which the river was free from freshets with the tidal volume passing the points below named, it is found that this inflow from above tidal influence forms about 9 per cent. of the tidal volume passing Bridesburg, about 30 per cent. of the tidal volume passing Burlington, N. J., and about 90 per cent. of the tidal volume passing Whitehill.

(5) *An estimate of the extent of the bowlders in the steam-boat channel just below Trenton.*—A series of borings to a depth of at least 12 feet below mean low water were made between the steam-boat wharf at Trenton, N. J., and Periwig Shoal, about 3 miles below. These borings, contrary to general opinion, show that no rock in place occurs within at least 12 feet below mean low water. Bowlders, from a few inches to over a foot in diameter, cover the bed of the river from the steam-boat wharf to a point about 2,500 feet below; from this point to Periwig Shoal, a further distance of about 12,000 feet, the bed of the river consists of coarse gravel mixed with small bowlders. Below Periwig Shoal the bed of the river is composed of fine sand.

This deposit of bowlders and gravel has resulted from the heavy spring freshets, which usually occur at the breaking up of the ice from the Upper Delaware River.

IMPROVEMENT OF THE DELAWARE RIVER BETWEEN BRIDESBURG, PENNSYLVANIA, AND TRENTON, NEW JERSEY.

With this summary of the general results of the survey I pass to a consideration of the improvement of the Delaware River between the upper part of deep water at Port Richmond, which is about 3 miles below Bridesburg, and Trenton, N. J. Although this section of 3 miles, between Port Richmond and Bridesburg, is below the part of the river which has been considered in the previous part of this report, it is so intimately connected with the improvement of the river above Philadelphia that it can not be omitted in this connection.

The commercial requirements of the Delaware River between Port Richmond and Trenton naturally divide the river into the following four parts:

(1) From deep water at Port Richmond to the northern limits of the city, a distance of 9 miles.

(2) From the city limits to Burlington, about 7 miles.

(3) From Burlington to Bordentown, about 10 miles.

(4) From Bordentown to Trenton, a distance of about 5 miles.

(1) *From Port Richmond to the northern limits of the city.*—For this distance of 9 miles the upper 7 miles from Five Mile Point to the city limits carries a low-water channel with a least depth of 18 feet at mean low water. This minimum depth occurs about opposite the House of Correction, where a cross-over bar 2,400 feet in length between the 24-foot curves above and below the bar exists. By the improvement of this bar a 24-foot channel could be carried from Five Mile Point to the city limits. The 2 miles of river between Port Richmond and Five Mile Point is covered by Five Mile Bar, across which there is at present a channel depth, obtained by the action of Fisher's Point Dike, of 12 feet at mean low water.

The future development of the port of Philadelphia will ultimately render of great value the 7 miles of deep water between Five Mile Point and the northern limits of the city of Philadelphia, and probably justify the ultimate improvement of the channel over Five Mile Bar to a depth at least as great as the ruling depth of the 7 miles of river above. The improvement of Five Mile Bar, which is now in progress, forms a part of the project for the permanent improvement of the Delaware River between Philadelphia and deep water in the bay. Until this has been accomplished there will be no necessity for any improvement of the natural channel between Five Mile Point and the city limits.

(2) *From the city limits to Burlington.*—This section of 7 miles carries a minimum low-water channel depth of from 14 to 15 feet, and will probably meet all commercial requirements for many years to come. Its material improvement beyond this natural depth would involve the improvement of the channel for a large part of the distance.

(3) *From Burlington to Bordentown.*—For this distance of about 10 miles the natural channel carries a low-water depth of from 12 to 13 feet except at two points, viz, Kinkora Bar, which is 5½ miles above Burlington, and in the 2,600 feet directly below the mouth of the Delaware and Raritan Canal at Bordentown.

At Kinkora Bar the ruling low-water depth is 7½ feet, and the 12-foot curve below the bar is separated from the 12-foot curve above by a distance of 1,200 feet. In the 2,600 linear shoal channel directly below the mouth of the canal a low-water depth of from 6 to 7 feet exists.

The principal traffic passing over this third section of the river is to and from the Delaware and Raritan Canal. The depth over the miter

sills of the canal is 8 feet, and consequently that depth becomes the ruling draught of vessels passing the canal.

The canal traffic between its mouth and Philadelphia is by canal-boats in tows, moved by steamers. It is claimed by the canal interests that its traffic would be greatly facilitated if they could use steamers and tugs with increased draught, and consequently increased power. The ruling depth of 7 to 8 feet which now obtains at Kinkora Bar and below the mouth of the canal limits the draught of tugs and steamers passing these points at low water to about 7 feet. The annual freshets are very severe in the upper river, and have hitherto obliterated the portions of channels in the vicinity of Bordentown dredged beyond a depth of 6 or 7 feet, consequently it is not believed that the 2,600 feet of shoal channel directly below the mouth of the canal is susceptible of material increase of depth by dredging unless it is repeated after each freshet.

To permanently improve this channel it would be necessary to practically extend the canal to Whitehill, a distance of about a half mile, but this could scarcely be considered a legitimate work to be undertaken by the General Government.

Since the mouth of the canal is separated from the deep water at Whitehill by only this distance of 2,600 feet, it is feasible to make up the tows for the steamers at the latter point instead of at the mouth of the canal. Under such conditions the shoal areas at Kinkora Bar would present the only obstruction to a 12-foot low water depth for all parts of the river below Whitehill.

From a study of Kinkora Bar it is believed that the existence of the bar is mainly due to the diversion of a large part of the flood current into the slough to the south of Newbold's Island, and by nearly closing the mouth of this slough by means of a dike and aiding the action of the concentrated currents on the bar by dredging, that an improved condition of the bar to a depth of about 12 feet at mean low water can be secured and maintained.

Such a dike should run from the lower end of Newbold's Island towards the outer end of the old wharf at the lower angle of the slough, leaving an opening between the end of the dike and the end of the wharf of about 100 feet. This opening would be required by the ice and brick interests located on the slough in shipping produce to market.

The length of dike beyond the low-water line would be about 600 feet, with an extension of about 250 feet between low and high water lines. By the use of a construction for the 600 feet of dike similar to that used at Fisher's Point, with an earthen embankment faced with stone for the 250 feet of extension between low and high water lines, the cost of the work of closing the slough will be about $12,000. If, as I think probable, the action of the dike should require to be supplemented by dredging a channel across the bar to a depth of 12 feet and a width of 100 feet, it would require the removal of about 20,000 cubic yards of material at an estimated cost of $4,000.

With this improvement of Kinkora Bar consummated, all requirements of commerce on the third section of the river would probably be met for a long time to come.

(4) *From Bordentown to Trenton, New Jersey.*—For this distance of 5 miles the river is badly obstructed with sand and gravel bars, which carry a depth of from 2 to 5 feet. These bars seem to be the results of the heavy spring freshets, which frequently attain a height of from 14 to 17 feet above mean high water. Over $100,000 were expended between

1873 and 1884 in dredging in this part of the river, and it may be said that all traces of such channels have long since disappeared.

The commerce of the river between Bordentown and Trenton is now and has been for several years carried by a single steamboat drawing about 5 feet of water, and arranging her trips so as to pass the shoal areas between Bordentown and Trenton at about high water.

It is believed that any valuable and permanent improvement of this section of the river would require the expenditure of a much larger sum than would be justified.

RECOMMENDATIONS.

In view of the foregoing, it would seem that the present requirements of commerce for that part of the Delaware River lying between Bridesburg, Pa., and Trenton, N. J., do not demand any improvement of the natural channel except at Kinkora Bar.

At that locality I would respectfully recommend the application of the $15,000 now on hand and available for the improvement of the Delaware River above Bridesburg to the construction of a dike such as already described at an estimated cost of about $15,000.

Should the construction of such a dike leave any available balance, it should be applied to dredging a channel across the bar to a depth of 12 feet at mean low water.

The report * of Assistant Engineer L. Y. Schermerhorn upon the survey of the river, together with the 5 sheets of tracings, are transmitted herewith.

Very respectfully, your obedient servant,

HENRY M. ROBERT,
Lieutenant-Colonel of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

G 2.

IMPROVEMENT OF HARBOR BETWEEN PHILADELPHIA, PENNSYLVANIA AND CAMDEN, NEW JERSEY.

In March, 1888, the Secretary of War, in compliance with a joint resolution of Congress, appointed a Board of Engineers, consisting of Cols. William P. Craighill and C. B. Comstock and Lieut. Col. Henry M. Robert, to examine, in all their relations to commerce, the islands known as Smith's Island, Windmill Island, and Petty's Island, in the Delaware River, between the cities of Philadelphia and Camden, to determine whether these islands or any shoal in the river between or adjacent to the islands constitute an obstruction to the commerce of the Delaware River between the States of Pennsylvania and New Jersey; and, with a view to their removal, to report a plan, with the estimate of cost for such removal in whole or in part, including the probable cost to the Government of said islands.

The Board of Engineers, under date of March 30, 1888, recommended a plan for the improvement of the harbor of Philadelphia, which involved the removal of Smith's and Windmill Islands and a part of

*Omitted.

Petty's Island, together with the shoals in the vicinity of these islands. The project provided for the formation of a channel 2,000 feet wide from Kaighn's Point to Fisher's Point, with the half width of the channel on the Pennsylvania side 26 feet deep at mean low water, and the remaining width of 1,000 feet with a depth decreasing from 26 feet to 12 feet at the New Jersey side. The position of this improved channel is to be such as to permit the widening of Delaware avenue and the extension of the wharves along the Philadelphia front from opposite Kaighn's Point to the foot of Petty's Island. The estimated cost of the project, exclusive of the cost of the islands, is $3,500,000.

The river and harbor act of August 11, 1888, contains the following appropriation:

Improving the harbor of Philadelphia: For the removal of Smith's Island and Windmill Island, in the State of Pennsylvania, and Petty's Island, in the State of New Jersey, or such parts of them and the shoals adjacent thereto as may be required, and for the improvement of the harbor between the cities of Philadelphia, Pennsylvania, and Camden, New Jersey, five hundred thousand dollars: *Provided*, That no part of this sum shall be expended until the title to the lands forming said islands shall be acquired and vested in the United States without charge to the latter beyond three hundred thousand dollars of the sum herein appropriated.

Proceedings in condemnation of Smith's and Windmill islands were commenced in December 1888, and for the part of Petty's Island required under the project in July, 1889. The commissioners appointed by the courts awarded the owners of Smith's and Windmill islands the sum of $484,000, and of Petty's Island $202,288.50; the legal costs of the condemnation proceedings were $22,364.36, making the aggregate cost of the property taken $708,652.86.

The title to the property condemned having been approved by the Department of Justice, instructions were received May 24, 1890, to apply in payment for the islands the $300,000 appropriated by act of August 11, 1888, after the balance had been paid by the State of Pennsylvania and city of Philadelphia. This requirement was complied with by the payment of $200,000 by the State of Pennsylvania, $208,652.86 by the city of Philadelphia, and $300,000 by the United States. The latter payment was completed on June 27, 1890.

The act of March 2, 1889, making appropriations for the naval service for the fiscal year ending June 30, 1890, provided $75,000 for dredging and filling in at League Island, and in the expenditure of this sum the Secretary of the Navy is authorized to co-operate with the Secretary of War in utilizing any material that may be removed from adjacent waters under appropriations made by Congress.

At the close of the fiscal year a project was under consideration, in compliance with the instructions of the Department, for the application of the sum above mentioned; and also of the $200,000 remaining from the appropriation of August 11, 1888, to the work of removing the islands.

This work lies in the collection district of Philadelphia, at which, as a port of entry, there was collected during the year ending December 31, 1889, revenue to the amount of $22,612,956.17. The nearest fort and light-houses are, respectively, Fort Mifflin and Schuylkill River range-lights.

Total appropriations to June 30, 1890	$500,000.00
Total expenditures to June 30, 1890	300,177.91

Money statement.

July 1, 1889, amount available		$500,000.00
July 1, 1890, amount expended during fiscal year ($300,000 of which applied to purchase of lands), exclusive of liabilities outstanding July 1, 1889	$300,177.91	
July 1, 1890, outstanding liabilities	1.50	
		300,179.41
July 1, 1890, balance available		199,820.59
Amount appropriated by act of September 19, 1890		200,000.00
Amount available for fiscal year ending June 30, 1891		399,820.59
Amount (estimated) required for completion of existing project		3,100,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892		1,000,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

G 3.

IMPROVEMENT OF SCHUYLKILL RIVER, PENNSYLVANIA.

The act of August 11, 1888, appropriated $25,000 for continuing the improvement of the Schuylkill River. This amount was practically expended during the fiscal year ending June 30, 1889, in widening and deepening by dredging the channel between Point Breeze and Penrose Ferry Bridge.

The river between its mouth and Gibson's Point, in its unimproved condition, carried a channel over the bar directly at its mouth with a depth of about 10 feet at mean low water, and between the bar and Gibson's Point a ruling depth of about 16 feet.

The present project proposes the formation of a channel 400 feet wide and 24 feet deep at mean low water from the mouth of the river to Girard Point, a distance of about 1 mile; from thence to Gibson's Point, a farther distance of about 3 miles, a channel 20 feet deep and 250 feet wide; from thence to Chestnut Street Bridge, Philadelphia, a distance of about 3 miles, a channel of navigable width and 18 feet deep at mean low water. This latter reach of river has required no other improvement than the removal of about 1,000 cubic yards of rock near Locust and South streets. The channels proposed are to be obtained by dredging, at an estimated cost of $485,000, of which amount $393,750 has been appropriated.

The improvement of the channel of the Schuylkill River by dredging was commenced in 1870, and up to the close of the present fiscal year about 1,320,000 cubic yards of material have been removed, of which about 550,000 cubic yards have been dredged in the formation of the channel near the mouth between deep water in the Delaware River and Girard Point, a distance of about 1 mile. The remaining 760,000 cubic yards have been removed from between Girard Point and Gibson's Point, a distance of about 3 miles.

This work has resulted in the formation of a channel about 150 feet wide and 20 feet deep at mean low water across the bar at the river's mouth; a channel 250 feet wide and from 20 to 24 feet deep from inside the bar to Penrose Ferry Bridge from thence to Point Breeze a channel 250 feet wide and 20 feet deep, except in the half mile of river directly

above the bridge where the 20-foot channel is only 100 feet wide; and from Point Breeze to Gibson's Point, a channel from 100 to 200 feet wide and 18 to 20 feet deep. Between Gibson's Point and deep water inside the bar at the mouth the improved channel has maintained the depth to which it was dredged.

The channel over the bar, although twice dredged to a depth of 24 feet at mean low water by the removal of about 550,000 cubic yards of material, has quickly shoaled to 20 feet; to redredge this channel to the dimensions proposed in the project, viz, 400 feet wide and 24 feet deep, would require the removal of at least 350,000 cubic yards of material.

The shoaling principally occurs over a portion of the channel about 1,500 feet in length, and situated directly at the river's mouth. It is mainly due to the abrupt angle at which the tidal currents of the Schuylkill meet those of the Delaware River, and the abnormal width of the former river at this point. From the experience of the past it seems highly probable that, instead of attempting to maintain the desired depth of 24 feet in this part of the river by dredging, it would be more assuredly and economically accomplished by the aid of a dike so placed as to produce tidal concentration upon the shoal area.

The present demands of commerce limit the requirement of an improved condition of river channel to that part of the river lying between the mouth and Gibson's Point, or the lower 4 miles of the river. At Girard Point are located large grain elevators and wharves. At Gibson's Point and Point Breeze, which are near each other and closely related as to commercial requirements, are the large storage tanks and wharves of the petroleum oil refineries. The interests assembled at these three points cover mainly the commerce of the Schuylkill River, and both the grain and oil trade require deep-draught vessels for the proper and economical transaction of their business. Channel depths should exist which will permit the passage of vessels at all stages of the tide between the mouth of the river and Gibson's Point drawing 24 feet of water. As it now is and will be until such a 24-foot channel is formed between Gibson's Point and the mouth of the river, deep-draught vessels will be permitted to move only at high water, or else obliged to lighter part of their cargoes.

The work already done is of great benefit to commerce, and the further improvement of the river is highly desirable. If funds become available for continuing the improvement, they should be first applied to deepening and widening the channel in the half mile of river directly above Penrose Ferry Bridge, where about 75,000 cubic yards of material are yet to be removed to complete the formation of the 20-foot channel to the proposed width of 250 feet. After this is accomplished the permanent improvement of the bar at the mouth should be undertaken, and subsequently the present project for the improvement of the river should be expanded so as to provide for the formation of a channel 24 feet deep at mean low water between Girard Point and Gibson's Point, and the further widening of the channel at Yankee Point, where the abrupt change of direction is a great inconvenience to navigation.

This work lies in the collection district of Philadelphia, at which, as a port of entry, there was collected during the year ending December 31, 1889, revenue to the amount of $22,612,956.17. The nearest fort and light-houses are, respectively, Fort Mifflin and Schuylkill River range lights.

Total appropriations to June 30, 1890	$393,750.00
Total expenditures to June 30, 1890	393,527.65

Money statement.

July 1, 1889, amount available	$368.37
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	146.02
July 1, 1890, balance available	222.35
Amount appropriated by act of September 19, 1890	45,000.00
Amount available for fiscal year ending June 30, 1891	45,222.35
Amount (estimated) required for completion of existing project	46,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	46,250.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Arrivals and departures of vessels during the year ending December 31, 1889.

Class.	Number.
Steamers	116
Sailing vessels	366
Total	482

Freight statement.

Received.		Shipped.	
Articles.	Quantity.	Articles.	Quantity.
Miscellaneous merchandise .....tons..	58,084	Petroleum .....tons..	543,000
		Grain.....do...	52,000
Total	58,084	Total	595,000

The above information was furnished by Messrs. Peter Wright & Sons, of Philadelphia, Pa.

G 4.

IMPROVEMENT OF ICE HARBOR AT MARCUS HOOK, PENNSYLVANIA.

The river and harbor act of August 11, 1888, appropriated $15,000 for this improvement. This amount was pactically expended during the fiscal year ending June 30, 1889, in deepening by dredging the shoal areas of the harbor, and in repairs to the landing of shore piers.

The work accomplished in 1889 practically carried the project for the improvement of this harbor to completion. The harbor in its present condition consists of an area of 10 acres, with a depth of from 18 to 25 feet at mean low water over about 7½ acres, and from 18 to 12 feet over the remaining 2½ acres. Within this area are seven detached ice-piers, consisting of stone superstructures upon timber crib substructures; two landing or shore piers of timber with crib superstructures upon pile foundations, and three groups of mooring piles placed between the detached ice-piers.

The four upper ice-piers were completed in 1871, and during the

eighteen years which have elapsed the wear of the ice upon the upper surfaces of the timber substructure, which is but slightly below the plane of mean low water, will necessitate in the near future repairs to this worn part of the substructure.

It is also probable that dredging will have to be resorted to at intervals to maintain the requisite depth of the water in the harbor. For these objects funds should be available.

This work is located in the collection district of Philadelphia. This is the nearest port of entry, the collections during the year ending December 31, 1889, amounting to $22,612,956.17. The nearest fort and light-house are, respectively, Fort Mifflin and Christiana Light.

Total appropriations from 1866 to June 30, 1890	$209,000.00
Total expenditures from 1866 to June 30, 1890	208,497.89

Money statement.

July 1, 1889, amount available	$654.11
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	152.00
July 1, 1890, balance available	502.11
Amount appropriated by act of September 19, 1890	5,000.00
Amount available for fiscal year ending June 30, 1891	5,502.11
Amount that can be profitably expended in fiscal year ending June 30, 1892 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	5,000.00

G 5.

ICE-HARBOR AT HEAD OF DELAWARE BAY, DELAWARE.

The act of August 2, 1882, contained an appropriation of $25,000 for "ice-harbor at head of Delaware Bay, and for removal of sunken piers in channel back of Reedy Island, Delaware." The sum of $3,700 was expended in 1883 in removing the sunken piers at Reedy Island, and $5,023.07 has since been expended in surveys, examination, and office expenses.

Several plans for the formation of an ice-harbor in the vicinity of Liston's Point have been proposed, but the difficulties connected with the problem have been such that a satisfactory solution has not yet been reached.

The greatest need of commerce on the Delaware River is an improved ship-channel between the port of Philadelphia and the sea, and until this shall have been carried further towards accomplishment, expenditures can be applied with more advantage to commerce to channel improvements than to ice-harbor construction.

The cost of an adequate ice-harbor in the vicinity of Liston's Point would probably be from $400,000 to $600,000, and after other requirements of commerce have been met, such an ice-harbor would be a desirable adjunct.

Total appropriation to June 30, 1890	$25,000.00
Total expenditures to June 30, 1890	8,723.07

Money statement.

July 1, 1889, amount available	$16,276.93
July 1, 1890, balance available	16,276.93

G 6.

CONSTRUCTION OF IRON PIER IN DELAWARE BAY, NEAR LEWES, DELAWARE.

The last appropriation previous to 1890 was that of $13,000 on August 2, 1882. This amount was expended in 1883–'84 in the renewal of a part of the decayed timber superstructure.

During the gale of March 12, 1888, a vessel was driven against the pier, breaking or bending five of the wrought-iron screw-piles to such an extent as to seriously injure about 100 linear feet of the structure. On September 13, 1889, during another gale, the bark *Il Salvatore* was driven from her moorings behind the breakwater and eventually collided with the pier at a point adjacent to the site of the previous injuries. The vessel was forced entirely through the pier, breaking or bending twelve additional piles and completely wrecking the superstructure of an additional 100 linear feet of the pier.

Under date of October 10, 1889, the officer then in charge of the district reported the matter to the Department with an estimate of $10,000 for the repair of the pier. The act of April 4, 1890, providing "for certain of the most urgent deficiencies in the appropriations for the service of the Government for the fiscal year ending June 30, 1890, and for other purposes," contained the following item: "Constructing pier in Delaware Bay, near Lewes, Delaware: For repairs, $10,000."

The plan for repairing the pier, submitted in compliance with the instructions of the Department dated April 11, 1890, proposes removing the seventeen injured piles and replacing them with cast-iron columns, bolted to timber sills, sunk below the action of scour. The cast-iron caps and diagonal bracing attached to the injured piles are to be utilized upon the columns and the timber superstructure restored upon its former plan of construction. To guard against the recurrence of similar accidents from colliding vessels or wrecks in the future, it is proposed to place fender-piles along both sides of the shore-arm of the pier. Timber on hand and stored upon the pier is to be used in these repairs. The approval of the above-described project for the repair of the pier was received at the close of the fiscal year.

During the fiscal year ending June 30, 1890, $78.60 was expended in the preparation of plans for the repair of the pier.

The pier consists of a substructure of wrought-iron piles, surmounted with a timber platform 11 feet above low water, and was designed to carry a railroad track so as to conform to the privilege granted in the act of July 15, 1870, the railroad having its terminus in the vicinity of the pier, "to extend their railroad upon and over said pier, and to freely use said pier in connection with their said road, subject to such regulations and charges for maintenance and repairs as the Secretary of War may adopt." The railroad has as yet shown no intention of exercising this privilege.

The increased weight of engines and rolling stock which have arisen since the pier was designed make the wooden superstructure too light to bear such increased loads. This, in connection with the perishable character of the superstructure, would, if the pier is ever used by the railroad company, render necessary an iron superstructure adjusted to the demands of modern railroad requirements. Such a plan, in accordance with Senate resolution of March 12, 1886, was submitted under date of April 2, 1886 (see Report of the Chief of Engineers for 1886, (pages 837–839) at an estimated cost of $93,000.

The pier is used occasionally by the quarantine service connected with the marine hospital at Cape Henlopen and others who desire to communicate with the shore from vessels entering the harbor, and by the Light-House Establishment for the temporary storing of a few buoys.

It is possible that in future breakwater construction the pier may afford facilities for carrying on the work, but before it can be utilized for such purposes the decayed wooden superstructure will require extensive repairs. The fender-piles which surround the outer end of the pier have either been broken or so nearly chafed off by vessels lying at the pier that their protective value is nearly destroyed. It is essential to the safety of the pier that the fender-piles be maintained with unimpaired strength.

To meet such requirements and to provide for contingent repairs there should be available at least $10,000.

The pier is in the collection district of Delaware, the nearest port of entry being Wilmington, where the amount of revenue collected during the year ending December 31, 1889, was $10,140.21. The nearest fort and light-house are, respectively, Fort Delaware and the Delaware Breakwater Light.

Total appropriations to June 30, 1890	$378,500.00
Total expenditures to June 30, 1890	368,453.66

Money statement.

July 1, 1889, amount available	$124.94
Amount appropriated by act of April 4, 1890	10,000.00
	10,124.94
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	78.60
July 1, 1890, balance available	10,046.34
Amount that can be profitably expended in fiscal year ending June 30, 1892 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	10,000.00

G 7.

IMPROVEMENT OF HARBOR AT DELAWARE BREAKWATER, DELAWARE.

The act of August 11, 1888, appropriated $100,000 for the continuation of this improvement. Under date of November 28, 1888, a contract was entered into with the Brandywine Granite Company for the delivery, at the price of $2.23 per ton, of about 41,000 gross tons of stone in the gap between the breakwater and the ice-breaker. During the past fiscal year 17,755 tons of stone were delivered, making the aggregate amount of stone furnished under the contract 40,950 tons. The contract was completed September 27, 1889.

The work in progress since the adoption of the existing project in 1882 has had for its object the closing of the gap of about 1,350 feet between the breakwater and the ice-breaker, by the deposition of random stone forming the substructure of the work. At the close of the fiscal year 101,713 gross tons of stone had been placed in the work, thereby nearly completing the random stone substructure.

A survey to determine the exact condition of the work was attempted in the fall of 1889, but the continuous stormy weather and rough condi-

tion of the bay prevented its accomplishment. It is proposed to complete this survey during the early summer.

The nearly completed condition of the random stone substructure made it necessary to provide for the proposed concrete superstructure, and under date of February 12, 1890, Lieut. Col. Henry M. Robert, then in charge of the work, submitted a revised project for the work remaining to be done, which was approved by the Department on February 20, 1890, and is appended hereto.

This project proposes that the random stone substructure shall be completed with a sea slope of 1 vertical to 2 horizontal, and harbor slope of 1 vertical to 1½ horizontal; the top of the superstructure to be 62 feet wide and 15 feet below mean low water. The concrete superstructure to have a cross-section of 27 feet high and 27 feet wide, with its top 7½ feet above mean low water. The superstructure from its base to a height of about 2 feet above high water to be built of concrete blocks; the remaining 5½ feet of height to consist of concrete in mass. The estimated cost of completing the work in accordance with this project was $500,000.

Within the last two years the shipping in the harbor has severely suffered from two unusually violent gales. On March 12, 1888, 27 vessels lying at anchor behind the breakwater, and in its vicinity, were driven ashore and wrecked. From September 9 to 13, 1889, the harbor was again swept by a severe easterly gale, during which the wind attained a velocity of from 60 to 75 miles per hour; 23 vessels were driven from their moorings behind the breakwater and wrecked upon the adjacent beach. Several vessels anchored in the bay and 10 miles north of the breakwater foundered and sunk at their cables. Most of the vessels driven upon the beach were subsequently released, but a number were so completely wrecked as to be incapable of removal. The heavy seas which swept directly through the gap between the breakwater and ice-breaker forced vessels away from the area of deepest water, thereby greatly restricting the available anchorage ground of the harbor. Although the seas swept away the bell-tower and platform at the lighthouse on the breakwater, no material injury was done to the breakwater beyond the displacement of a few stones from the sea slope at the northerly end of the work.

In the sixty-two years which have elapsed since the Delaware Breakwater was first planned, great changes have ensued in the character, dimensions, and draught of the vessels for which protection was required and provision made. In addition to this change of requirements, the deep water area then available for anchorage behind the breakwater has been greatly reduced by shoaling.

From these continued causes a necessity has arisen for a more ample harbor of refuge whereby protection can be given to the deep-draught vessels passing this part of the Atlantic coast, and in expression of this need the commercial and maritime interests of Philadelphia have already memorialized Congress.

Even assuming that such a deep-water harbor of refuge will become an accomplished fact, there nevertheless remains the necessity for completing the existing project of the present breakwater, whereby increased accommodation will be given to the four or five thousand fishing vessels and smaller coasting craft which yearly use the harbor and with advantage can continue to do so even after a more capacious harbor is built in the vicinity.

The Maritime Exchange of Philadelphia maintains a station on the breakwater, and through telegraph-cables between the mainland and

their station are in connection with the shipping of the harbor. The reports of the Maritime Exchange state that during the year 1889, 2,948 vessels, exclusive of tugs, fishing, and small coasting craft, anchored under the protection of the breakwater.

If funds are available, it is proposed, during the next fiscal year, to complete the substructure and commence the construction of the concrete superstructure. A detailed project for the execution of this work is now in course of preparation.

This work is situated in the collection district of Delaware. Wilmington is the nearest port of entry, at which the revenue collected during the year ending December 31, 1889, was $10,140.21. Fort Delaware is the nearest fort, and the Breakwater Light the nearest light-house.

Total appropriations to June 30, 1890	$2,548,353.70
Total expenditures to June 30, 1890	2,547,125.92
Total appropriations under present project to June 30, 1890	356,250.00
Total expenditures under present project to June 30, 1890	355,022.22

Money statement.

July 1, 1889, amount available		$5,075.72
July 1, 1889, amount covered by existing contracts		39,705.15
		44,780.87
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$43,649.85	
July 1, 1890, outstanding liabilities	74.43	
		43,724.28
July 1, 1890, balance available		1,153.35
Amount appropriated by act of September 19, 1890		80,000.00
Amount available for fiscal year ending June 30, 1891		81,153.35
Amount (estimated) required for completion of existing project		420,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892		420,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

SPECIAL REPORT ON DELAWARE BREAKWATER, WITH REFERENCE TO THE PLAN FOR CLOSING THE GAP BETWEEN THE BREAKWATER AND THE ICE-BREAKER.

UNITED STATES ENGINEER OFFICE,
Philadelphia, Pa., February 12, 1890.

GENERAL: I have the honor to submit the following report upon the Delaware Breakwater, with a recommendation that certain modifications be made in the present plan for closing the gap between the breakwater and the ice-breaker.

The original project for the Delaware Breakwater was submitted in 1828, and the work was completed in 1869, at a cost in round numbers of $2,200,000. The work consisted of two detached works of random stone 2,558 and 1,359 feet long, respectively, separated by an interval of 1,350 feet. The connecting of the two detached portions by filling the gap was commenced in 1883, and is still in progress.

The project for closing the gap provides for a brush mattress 2 feet thick and 100 feet wide, upon which is to be placed random stone to a height of 12 feet below mean low water, at which level it is to have a width of 48 feet with side slopes of 1 vertical on 2 horizontal; upon this rubble foundation is to be placed a monolithic superstructure of con-

crete, with a height of 24 feet and a width of 24 feet at the bottom and 12 feet at the top, which top is to be 12 feet above mean low water and about 7½ feet above mean high water.

The condition of the work at present is as follows: The brush mattress was completed in 1884, and 101,713 tons of random stone have been placed upon it, raising the rubble mound at places to within 12 feet of low water.

A survey to ascertain the exact condition of the rubble mound was attempted last fall, but had to be abandoned on account of the unprecedented stormy season. It required 1.5 tons of stone for every cubic yard of volume in the completed breakwater, and, as the rubble mound in the gap, with its proposed cross-section, would have a volume of 87,500 cubic yards, it would probably require about 131,250 tons of stone to construct the rubble mound on the present plan. Of this amount 101,713 tons have already been placed in the gap, leaving only about 30,000 tons yet to be placed to complete the rubble mound on the present plan.

It becomes necessary, therefore, to be prepared for at once commencing the superstructure.

An examination of the present plan has led me to doubt the wisdom of carrying it out in its details. My objections may be briefly stated as follows:

(1) *The superstructure is to be a monolith of concrete.*—This requires that the concrete shall be mixed on the breakwater or the ice-breaker, which are masses of rubble-stone, only 22 feet wide at top and rising only 8½ feet above mean high-water, and exposed to the force of the waves from the sea. Work could only be carried on in favorable weather while the entire force would have to be constantly employed. Material would have to be brought from a distance in quantities too large to be stored on the breakwater, which would necessitate their being stored on the shore. The room on the breakwater is so small that I can not see how the concrete could be mixed there except at great expense. If the concrete is mixed on shore and transported to the breakwater in boats, considering the uncertainty of prompt delivery from weather and other causes, there would appear to be great risk of much of the concrete being spoiled. In any case, I think the expense would be much greater than if the superstructure were made of concrete blocks, constructed where they could be made at least expense, considering the price of labor and of material. Even if the breakwater extended to the mainland so that there could be railroad communication between the place where the concrete was mixed and the work, yet even then I doubt the expediency of making the superstructure a monolith.

(2) *The cross-section of the superstructure is too light.*—The breakwater, when completed, will consist of a broken line composed of three straight lines, the middle one, corresponding to the gap, being much more exposed to the waves than the others. The present plan for the superstructure of this middle portion provides for a width of 24 feet at the bottom and 12 feet at the top, or a mean width of 18 feet. Judging from the experience of the past, I have no confidence in the ability of such a section to resist the force of the waves at the Delaware Breakwater. I am inclined to think an addition of one-third to the width would suffice, but to avoid all risk it would be better to add 50 per cent., so as to give a mean width of 27 feet instead of 18 feet.

Instead of sloping sides I would make them vertical, on account of the great inconvenience with the block system of having so many sizes as are necessitated by a constant change in width; and also because the

danger is more from sliding than overturning, and the rectangular section gives a greater resistance of friction by placing a larger volume of concrete out of the water, where its effective weight is nearly doubled.

(3) *The rubble mass is to have its top within 12 feet of low water.*—With vertical superstructures of concrete or masonry structures the force of the recoil of the wave or the undertow is felt to a very great depth, and late experience would lead to placing the foundation as low as 15 or 18 feet below low water at a place with the exposure of the Delaware Breakwater. The rubble mound is now at such a height that it would be expensive to make its tow lower than 15 feet below low water, and I would recommend that that height be adopted. This will require the removal of some stone, but the expense is justifiable.

(4) *Only 24 feet is allowed for the bermes at the foot of the superstructure.*—For the reasons just given for lowering the top of the rubble mass, I would recommend that there be a berme of 10 feet on the harbor side and 25 feet on the exposed side of the concrete superstructure. This would allow of the placing large size stone at the foot of the vertical wall on the exposed side, and add very much to the protection from undermining.

(5) *The rear slope of the rubble mass is too gentle.*—The rear slope is placed at 1 vertical to 2 horizontal, the same as the front slope. The rear slope of the present breakwater, which is more exposed, now stands at 1 vertical to 1.5 horizontal, so there is no need of providing for a gentler slope in the gap.

In accordance with the above views I would recommend the adoption of the following project for completing the Delaware Breakwater:

REVISED PROJECT.

Rubble mound.—The rubble mound to have side slopes of 1 vertical to 2 horizontal on the sea-face and 1 vertical to 1⅓ horizontal on the harbor face; its top to be 62 feet wide and 15 feet below mean low water.

Superstructure.—The superstructure to have a cross-section of 27 feet height and 27 feet width, its base being 15 feet below mean low water and its top 7½ feet above mean low water; the material of which it is composed to be concrete blocks up to about 2 feet above high water, the topping, after the blocks have settled, to be a mass of concrete; the foot of the superstructure to be protected on the sea-face by large blocks of stone weighing not less than 4 tons.

ESTIMATE.

20,000 tons rubble-stone, at $2.50 per ton	$50,000
10,000 tons very large rubble-stone, at $3 per ton	30,000
36,500 cubic yards of concrete placed in work, at $10 per cubic yard	365,000
Superintendence and contingencies	55,000
Total	500,000

This, together with the amount already appropriated, exceeds the estimate for the existing project of 1882 by $181,250.

Very respectfully, your obedient servant,

HENRY M. ROBERT,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. L. Y. SCHERMERHORN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Philadelphia, Pa., January 26, 1890.

COLONEL: I have the honor to submit the following general considerations relating to closing the gap between the breakwater and the ice-breaker at Delaware Breakwater Harbor.

The project for this work, which has been in progress since 1883, may be summarized under the three following subdivisions:

(1) Placing a brush mattress foundation 2 feet thick and 100 feet wide along the axis of the gap to prevent scour.

(2) The formation of a random stone foundation upon this mattress sill brought to a height of 12 feet below the plane of mean low water, with a top width of 48 feet and side slopes of 1 vertical upon 2 horizontal.

(3) The construction of a concrete superstructure upon the random stone foundation with a bottom width at 12 feet below mean low water of 24 feet and a top width at 12 feet above mean low water of 12 feet.

The first sub division was completed in 1884, and the second has been so nearly completed that it becomes necessary to consider in detail the third.

Even though the project stands committed to a concrete superstructure, it might be instructive to consider to what extent such a superstructure would be more economical than to continue with a construction similar in section to the existing breakwater.

From a study of the 26 sections of the breakwater taken in 1872, the mean section shown in accompanying sketch (Fig. 1, Plate 1) has been compiled.

The present slopes of the breakwater may be considered as slopes of equilibrium resulting from the action of waves thereon, and, since the gap will be exposed to forces in no way less than those impressed upon the breakwater, it would not be safe to assume a section for a random stone breakwater closing the gap less than that which is found to exist in the present breakwater.

The original depth of water over the site of the breakwater was about 30 feet as determined by the survey of 1828. The mean depth over the original site of the gap as determined from the survey of 1881 was 32 feet. Applying this increase of 2 feet to the mean section of the breakwater there will result a cross-sectional area of 495.3 square yards, or a volume for a random stone breakwater closing the gap of 165.1 cubic yards for each linear foot of the work.

Of this volume of 165.1 cubic yards, 106.3 cubic yards is below the plane of 12 feet, and 58.8 cubic yards above the plane of 12 feet below mean low water.

The average volume contained in the random stone foundation for the existing project of closing the gap is 65.1 cubic yards per linear foot of breakwater. From this it follows that there would be an excess in rubble stone of (165.1 − 65.1) 100 cubic yards per linear foot, if the present section of the breakwater was used in closing the gap in place of the proposed random stone foundation with a concrete superstructure. This excess of 100 cubic yards per linear foot will be divided as follows: 41 cubic yards will be below the plane of 12 feet and 59 cubic yards above the plane of 12 feet below mean low water.

From the experience gained in the construction of the breakwater it was found that each cubic yard of volume of the breakwater was equal to 1.5 gross tons of stone deposited. On this basis the above excess of 100 cubic yards would be divided as follows:

(41×1.5) 61.5 gross tons below the —12.0-foot plane.
(59×1.5) 88.5 gross tons above the —12.0-foot plane.

The contract cost of placing these quantities of stone may be estimated as follows:

61.5 gross tons at $2.50 =	$153.75
88.5 gross tons at $3.50 =	309.75
	463.50

This amount of $463.50 per linear foot of breakwater represents the difference in cost of an entire random stone breakwater and the random stone foundation required in the present project, or it is the amount which must be compared with the cost of the concrete superstructure upon the rubble base.

For the purpose of reaching an approximation it may be assumed that the cost of the necessary plant for making and placing the concrete superstructure will not exceed $60,000, or about $2 per cubic yard for the probable section of the concrete. If it be further assumed that in addition to the cost of this plant the concrete will cost $8 per cubic yard in place there will result an aggregate cost of $10 per cubic yard.

Dividing the previously obtained $463.50 by this cost of $10 per cubic yard and

there results 46.3 cubic yards or 1,250 cubic feet per linear foot of superstructure. Assuming that the superstructure will be 24 feet high, as provided in the existing project, there will result a mean width of (1250 ÷ 24) 52 feet. The present project provides for a superstructure 24 feet wide at base and 12 feet wide at top. If this section be increased to a uniform width of 24 feet, there would still remain the margin of (52 − 24) 28 feet in favor of the concrete superstructure, or a saving of 25 cubic yards per linear foot of breakwater.

This quantity at $10 per cubic yard represents a saving of $250 per linear foot, or for the entire length of the gap (1,350 feet by $250) $337,500.

Or it might be stated thus: with an assumed section to the concrete superstructure of (24 × 24 feet) 21⅓ cubic yards per linear foot the $463.50 would permit the concrete to cost ($463.50 ÷ 21⅓) $21.73 per cubic yard. Such a price is manifestly more than double that which would obtain in practice.

From the foregoing it becomes evident that a concrete superstructure will be far more economical than to repeat the present section of the breakwater.

COMPARISON BETWEEN THE EXPOSURE OF THE PRESENT BREAKWATER AND A WORK CLOSING THE GAP.

The destructive forces impressed upon a breakwater vary with the fetch of the severest seas, and also with the angle of incidence between the line of impact of such seas and the axis of the breakwater.

Other conditions being equal the force of impact of waves of translation varies with the $\sin^2$ of the angle of incidence as above defined.

It will be seen by reference to the chart of Delaware Bay that this angle will vary with the same wave in the case of the breakwater and the work closing the gap as follows:

Angle between—	Degrees.
B. W. and line to outer edge New Jersey coast	55
Gap and line to outer edge New Jersey coast	67
B. W. and line to outer edge Shoals	47
Gap and line to outer edge Shoals	58½
B. W. and line to middle exposure	30
Gap and line to middle exposure	42
B. W. and line to end Cape Henlopen	13
Gap and line to end Cape Henlopen	25½

Upon the assumption that the force of the same line of wave impinging upon the breakwater and upon the gap with the above angles of incidence, will be proportional to the $\sin^2$ of these angles, we will have, considering the normal impact as unity, the following:

Angle between—	
B. W. and line to outer edge coast	0.67
Gap and line to outer edge coast	0.35
B. W. and line to outer edge shoals	0.53
Gap and line to outer edge shoals	0.72
B. W. and line to middle exposure	0.25
Gap and line to middle exposure	0.45
B. W. and line to end Cape Henlopen	0.05
Gap and line to end Cape Henlopen	0.18

From this comparison the exposure of the gap from the sector which is unprotected by coast line or outlying shoals would be nearly double the exposure of the present breakwater. Even under these conditions the gap would still be exposed to forces which are only about one-half of those which would result if the axis of the gap was normal to the line of approach of unobstructed waves from the ocean.

It is probable that the apparent advantage of this obliquity of axis to the line of approach of maximum waves is in practice somewhat reduced by the tendency of the adjacent shore-lines to wheel the waves into lines approaching parallelism to the breakwater. That the obliquity of the axis of the breakwater to the lines of wave approach modifies the effective action of the waves is shown by the fact that the sea slopes are much steeper than those which are found upon European breakwaters of similar type subjected to full ocean exposure.

DESCRIPTION OF BREAKWATERS CONSISTING OF A CONCRETE SUPERSTRUCTURE FOUNDED UPON A RANDOM STONE SUBSTRUCTURE.

Such breakwaters have been built at the following localities:

Locality.	Latitude N.	Longitude E.
Colombo, Ceylon	7°	80°
Madras, India	13°	80°
Mormugao, India	22°	69°
Manora, India	25°	67°
Kustendjie, Turkey	44°	29°
Odessa, Russia	46°	31°
Fiume, Austria	45°	15½°
Ymuiden, Holland	52¼°	4½°

The following table gives the principal dimensions of these breakwaters:

Locality.	Base of superstructure below M. L. W.	Top of superstructure above M. L. W.	Total height of superstructure.	Width of superstructure.	Range of tides.	Height above high water.	Depth of water over site.
Colombo	*20	12	32	34	2.0	10	18-40
Madras	22	8	30	24	3.3	4.7	24-45
Mormugao	†18	‡20	38	30	6.0	14	20-28
Manora	15	9	24	24	8.7	0.3	18-30
Kustendjie §	†16	12	28	12-18	.....	12	12-20
Odessa §	22	10	32	22-28	.....	10	20-30
Fiume ‖	22¾	.....	24	23¼	1.5	1.5	20-70
Ymuiden	†25	18	43	28-38	5.5	12.5	40-30

* Rubble and 10-ton bags of concrete extend about 5 feet above the base.
† Sea-face and slope protected with large concrete blocks.
‡ Includes a parapet 7 feet high and 15 feet thick.
§ Upon the west shore of the Black Sea.
‖ Upon the Gulf Quarnero, Adriatic Sea.

Of the foregoing breakwaters Colombo, Madras, Mormugao, Manora, and Ymuiden are exposed to ocean waves; Kustendjie and Odessa to the waves of the Black Sea, and Fiume to the waves of the Gulf of Quarnero, on the Adriatic Sea.

The exposure to which these breakwaters are subjected may be divided into two classes, the five subjected to ocean exposure falling into the first class, and the remaining three into the second class. In using the experience which has resulted from these works as a criterion for construction at Delaware Breakwater, it would seem only natural to accept the exposure of the first group as more similar in general conditions to the Delaware Breakwater than the second.

DEPTH OF CONCRETE SUPERSTRUCTURE BELOW MEAN LOW WATER.

In the five works comprising the first group the foundations of the concrete superstructure are placed from 15 to 25 feet below mean low water. This might have been adopted for two reasons, viz: (1) Economy of construction; (2) Stability of the work.

In the case of Ymuiden Breakwater, where the rubble base was only 3¼ feet in thickness, it seems highly probable from the known absence of stone within reasonable distance from the site of the work that the depth of 25 feet was chosen from grounds of economy. Excluding Ymuiden, for the remaining four works the depth of the concrete foundation varies from 15 feet at Manora to 22 feet at Madras.

The earlier breakwaters, even when provided with a superstructure or parapet, presented to the sea a face of random stone, with slopes of from 1.5 to 1.7 between high water and about 12 feet below mean low water. The effect of these long flat slopes leading up to the parapet naturally reduced the force of the waves and materially lessened the back draught of the seas and their effect upon the stone forming the sea-slope below the surface of low water.

From the experience gained in the older types of breakwaters it was inferred that the waves had no influence upon large rubble at a depth of 12 feet below mean low water; but that which was true of the older types, with flat slopes extending well above the surface of the water, ceased to be true when the wave was met by a vertical wall founded at a depth of 12 feet or more below mean low water. The recoil of a wave from a vertical face is so much more severe than the recoil from a long flat slope, that it seems only natural to expect that the disturbance of the rubble base in the former case would be carried to a much greater depth than in the latter. Consequently the limiting depth at which rubble was found to be undisturbed in the older types of breakwaters was not a safe criterion when applied to breakwaters sur-

mounted with a vertical superstructure extending well below the surface of mean low water.

This radical difference between the action of a vertical wall and flat slopes of random stone has resulted in material changes of opinion as to the limiting depth of wave disturbance, and where a depth of 12 feet was formerly considered sufficient to place rubble-stone beyond the action of waves, depths of 18, and even 22, feet are now advocated and used.

At Alderney the rubble base was originally placed at 12 feet below mean low water, but before a condition of stability was attained the top of the rubble mound at the base of the superstructure had been reduced to a depth of between 15 and 18 feet, and even at this depth it was necessary to maintain the top of the rubble with added material to replace that which was swept away. There is most manifest economy in either placing the rubble so low at the first as to secure its stability, or else protecting it with stone too large to be removed. Otherwise the stability of the whole work is endangered, or else a large annual expense must be incurred to supply the waste and thereby insure the work.

At Tynemouth, where the superstructure is founded at a depth of 20 feet below mean low water, it has been necessary to protect the top of the rubble mound on the sea-face with a double row of large concrete blocks.

At Colombo the base of the superstructure at 2,000 feet from the shore, and in water 30 feet deep, is placed 16 feet below mean low water, but the sea-face of the work is protected by large rubble-stone raised to a height of 5 feet above the base, and such stone further protected with a close layer of 10-ton bags of concrete. At 3,000 feet from the shore, and in water 40 feet deep, the superstructure is carried to a depth of 20 feet below mean low water, and then protected by large rubble and concrete bags

At Madras the base of the superstructure, founded 22 feet below mean low water, seems to have been sufficiently deep to protect the top of the rubble base from the effect of wave recoil. Nevertheless, in the amended project for the extension of the Madras breakwater a wave-breaker is provided along the sea-face of the superstructure, consisting of large random blocks of concrete piled against the sea-face and extending to the plane of high water.

At Mormugao the base of the superstructure, founded 18 feet below mean low water, has been protected on its sea-face by a wave-breaker consisting of 20-ton concrete blocks extending above the plane of high water.

At Manora the superstructure, founded at 15 feet below mean low water, has not suffered from any reduction of the rubble base. This is probably due to the reduced exposure of the locality, joined with the fact that the superstructure is so low, practically the plane of mean high water, that the seas easily pass over the work, and consequently greatly reduce the back-draught or recoil of the waves.

At Kustendjie the superstructure, founded at 16 feet below mean low water, is protected on the sea-face with large random stone blocks, which extend about 8 feet above the base of the superstructure.

At Odessa, where the superstructure is founded 22 feet below mean low water, the rubble base has not required protection.

At Ymuiden, although the superstructure is founded at a depth of 25 feet below mean low water, the sea-face is provided with a wave-breaker of large concrete blocks extending above the plane of high water. This added precaution was probably made necessary for the reason that the rubble base was only 3½ feet in thickness, and being founded on yielding sand, it became imperatively necessary to protect the sea-face from currents which would produce scour and the consequent settlement of the entire work.

With the exception of the Manora Breakwater, the top of which is not above mean high water, we find that even when the base of the superstructure is placed at from 18 to 22 feet below mean low water it has been considered necessary to give increased assurance to the rubble base by special protection. While the formation of wave-breakers undoubtedly strengthens an otherwise weak superstructure it is highly probable that the expenditure of a less amount of money applied towards placing the foundations at a lower level or in giving increased thickness to the superstructure, would produce better results.

From the foregoing it may assumed that the best modern practice would place, in localities subject to ocean exposure, the base of the superstructure at from 15 to 22 feet below mean low water, and even then give the top of the rubble mound additional security by the use of large stone or concrete blocks.

COMPARATIVE EXPOSURE OF THE DIFFERENT LOCALITIES UNDER CONSIDERATION.

The forces tending to the destruction of a breakwater depend upon the exposure of the site, or, in other words, upon the height and velocity of the extreme waves which the work will be required to meet and the angle of incidence of such waves with the breakwater.

At Colombo the direction of the breakwater from the land is N. 10 E., and this

direction makes an angle of about 30° with the northwest monsoons and 58° with the southwest monsoons. These monsoon winds are of long duration and produce the heaviest seas which have been observed at Colombo. Of the two directions named the southwest monsoons are the most severe, and that of July, 1878, which somewhat injured the work and led to a change in the section of the breakwater, produced waves 15 feet high from trough to crest and with a velocity of about 35 feet per second.

At Madras the directions of the breakwaters are S. 72° E., converging by return arms at angles of 70° with the short arms.

The site is more exposed to heavy seas than at any other of the localities under consideration. Besides the monsoon gales, severe cyclones occur in May and November, which impress heavy seas upon the breakwaters. No information is given as to the angle of incidence of the severest storms, but it is stated that waves over 15 feet in height are experienced. When the work was nearly completed in 1881 a cyclone from the north severely injured the breakwater by wrecking the converging arms and detaching blocks from the shore-arms of the work. The destruction of the former was caused by the side-long rush of the sea, which disturbed the rubble base, and the displacement of the blocks from the shore-arms was due to the total lack of horizontal bond between the blocks.

At Mormugao the direction of the breakwater is N. 21° E., and the work is fully sheltered from all winds except from the southwest around to the northwest. The heaviest seas arise from the southwest monsoon which strikes the breakwater at an angle of about 30°. The site is much less exposed than Madras or Colombo, but the breakwater has 25 per cent. greater width than the former, and in addition is provided with a heavy wave-breaker of random concrete blocks. The plan for the work was designed just at the time that the Madras breakwater had met with its disaster, and Harcourt considers that the wave-breaker at Mormugao was simply an additional precaution against the experience of Madras.

At Manora the breakwater has a direction of S. 12° E. The severest storms to which it is exposed are the southwest monsoons, which produce waves 15 feet high, 300 feet apart, and with a velocity of about 30 miles per hour. These waves impinge upon the breakwater at an angle of about 70°. The work was planned for a superstructure about 4 feet above mean high water, but subsequent settlement reduced its top surface to the plane of high water. On account of this limited height of superstructure the heavy seas pass entirely ever the work. During such gales the superstructure has a swaying motion, and even under moderate swells it rocks laterally at the top one-fourth of an inch.

The breakwaters at Kustendjie, Odessa, and Fiume, located upon inland seas, present such modified conditions of exposure as to render them of less value than the preceding cases of works exposed to oceanic seas.

At Ymuiden the breakwaters cover the sea end of the Amsterdam Canal, and are built on converging lines from a low, sandy shore. The direction of the northern breakwater is east and west, that of the southern N. 65° W. No definite information has been found as to the height or velocity of waves during severe gales, beyond the general statement that the low, flat shores of this part of the North German Ocean are exposed to heavy seas with high surf. The inference seems to obtain that the shallow depth in the vicinity of Ymuiden greatly reduces the velocity with which the waves reach the breakwaters.

To determine the most economical dimensions for a breakwater at any given locality, requires that the maximum exposure be fairly known. Such exposure can not be predicated upon averages, but must take into consideration the effects likely to result from the most fortunate combination of infrequent causes and all tending to produce waves of the greatest possible height and velocity. Such results would not follow from ordinary severe gales, but would rather belong to tidal waves or cyclonic storms. It is also possible that a series of heavy isochronous waves might fall upon a breakwater superstructure so as to induce therein a swaying motion, which would become augmented if the interval of such waves was in rhythm with the movement of the superstructure until the work yielded to the increasing vibrations.

If the exposure at any locality where a breakwater has successfully stood can be fairly compared with the exposure of the locality for which a breakwater is to be designed, then, other conditions being similar, a reasonably safe criterion is obtained. But every new determination must be so largely a question of judgment that, even after the most careful comparisons, assurance of results can not be assumed unless quite a large margin is allowed to cover unrecognized differences of conditions.

In considering the question of the proper dimensions to be given to a breakwater superstructure, more valuable indications are to be obtained from the cases of failures of works than in the successes.

The Madras Breakwater, as already stated, failed entirely from an error in the details of construction, by which no bond was given to the blocks of the superstructure in a direction transverse to the axis of the breakwater. The Manora Breakwater con-

tained the same source of weakness, but its reduced height (the plane of high water) saved the superstructure from a fate similar to that of Madras.

Of the remaining breakwaters which have been considered, Colombo furnishes the only case of partial failure which could be used as a valuable indication of the necessary section of a breakwater to withstand the action of an exposure similar to that of Colombo. As originally designed, the breakwater was rectangular in section, with the dimensions shown on sketch. (Figs. 3 and 4, Plate 1.)

The breakwater was given a width of 50 feet, so as to utilize the top as a quay. This width of 50 feet consisted of a sea-wall 24 feet thick, hearting-wall of rubble-stone 14 feet thick, and a harbor-wall 12 feet thick. In the construction of the work the sea-wall was kept about 700 feet in advance of the harbor-wall.

In July, 1878, when the breakwater had attained an extension of about 1,300 feet from the shore, and when the 24-foot thick sea-wall was 700 feet in advance of the harbor-wall, an unusually heavy southwest monsoon caused a horizontal displacement of the outer end of the advanced sea-wall "to the extent of 15 inches, pivoting on a point 150 feet landward, and lowering the outer end 12 inches, diminishing to nothing 450 feet inshore." * * * "The signs of weakness which indicated the inadequacy of the sea-wall to sustain unaided the thrust of the sea" led to a modification of the hitherto adopted plan. The use of the breakwater as a quay was abolished, because it was found that the waves swept over the top of the work with too much force to permit its use for such a purpose. The failure of a superstructure 24 feet in thickness to withstand the shock of the seas had been demonstrated; consequently the further progress of the sea-wall was delayed until the harbor-wall could be brought up to its outer end. Then the dimensions of superstructure were modified by omitting the rubble-hearting between the sea and harbor walls and uniting the two walls in one section 34 feet in thickness. This width was continued for the remaining 3,000 linear feet of the breakwater.

At the time of this failure of the sea-wall the top of the concrete blocks had not yet been covered with the monolith of concrete 4 feet in thickness, which after all settlement had ceased was finally placed so as to unite the tops of the blocks. Although an increased stability would have been given to the wall by this concrete capping, yet, on the other hand, the added height of 4 feet would have subjected the superstructure to an increased displacing force from the waves. This experience at Colombo was most valuable, and indicates that under a similar exposure the thickness of the superstructure to insure stability must be something greater than 24 feet. With the wall 34 feet in thickness, no difficulty has subsequently occurred, and of course it is not demonstrated that a less thickness than 34 feet would not have insured stability. The failure of the wall when 24 feet thick and the success of the wall when 34 feet thick simply indicates that somewhere between these limits assured stability was reached.

METHODS OF CONSTRUCTION ADOPTED AT THE FOREGOING BREAKWATERS.

For general dimensions see table, page 896.

In general terms the superstructure of the breakwaters of Colombo, Madras, Mormugao, Manora, and Kustendjie consisted of superposed blocks of concrete arranged in a series of sections, each free to settle in planes transverse to the axis of the breakwater independently of the other sections and without the disruption of any bond between these sections, and yet each massive enough to withstand the shock of the seas.

The general plan of these superstructures is shown on Plate 2, Figs. 1, 2, 3, 4, and 5.

The transverse planes of the sections are inclined to the horizontal at the angles shown.

The superstructure of the breakwaters of Odessa and Ymuiden consists of concrete blocks laid in horizontal courses as ordinary bonded masonry. The superstructure of the Fiume Breakwater, in part, consists of concrete in mass deposited in frames in the water, so as to make a monolith of the entire superstructure.

Dimensions of blocks in the first five breakwaters.

Locality.	Height.	Depth.	Length.	Weight.
	Feet.	*Feet.*	*Feet.*	*Tons*
Colombo	6	5½	8, 9, and 14	17 to 30
Madras	8	4½	12	27
Mormugao	8	4½	13 and 17	28 to 37
Manora	8	4½	12	27
Kustendjie	6	5	12 to 18	20 to 30

At Colombo each sloping section of blocks was prevented from transverse movement by five joggles, consisting of oblong grooves formed in the blocks and filled subsequently with concrete in bags. These grooves were 18 inches in a direction at right angles to the axis of the breakwater and gave for each set of sloping blocks a united cross-section of 225 square feet.

At Madras the blocks of each sloping section are connected by a mortise and tenon 4½ inches wide and 2½ inches deep, formed on the top and bottom respectively of each block, but no attempt was made to connect the sea and harbor rows of each section or the several sections together.

In the revised plans for the extension of this breakwater, provision is made for clamping together the upper pair of blocks. This lack of transverse bond was the cause of a part of the injury to the breakwater which occurred in 1881.

At Mormugao similar mortises and tenons were used to those described for Madras, and in addition a rectangular vertical joggle 15 inches square connected each pair of blocks of the upper two courses. The upper pair of blocks were further secured together by 2-inch square iron clamps and a dowel of iron 7 feet long penetrating 3½ feet into the upper pair of blocks. (Plate 1, Fig. 5.)

At Manora no attempt was made in any way at first to connect the sections of blocks. Subsequently, when it was found that the action of the sea displaced the upper blocks, an attempt was made to add to their stability by inserting stone dowels between the top blocks and the block immediately below. The breakwater still remained as two independent walls placed side by side without even a connection at the top between them.

At Kustendjie the blocks extended entirely through the wall in single pieces, and no attempt was made to connect the blocks of each section, or the sections together.

The general arrangement of joggle bond between the blocks at Colombo not only connects the several sections, but also the individual blocks of each section and seems to be an evolution from the methods which had preceded. Mr. Kyle, the resident engineer of the Colombo works, stated before the Institution of Civil Engineers that while the system adopted worked well, it was still open to improvement.

In the Colombo, Madras (revised), Mormugao, and Kustendjie breakwaters the top of the blocks, after settlement had ceased, were tied together by a monolithic mass of concrete for the entire width of the superstructure and from 4 to 6 feet in depth. Such a mass of concrete, besides securing the upper blocks, protected the top of the work from the pounding action and sweep of the seas, and largely removed the danger of injury from the compression of air or water in the upper joints of the blocks.

At Kustendjie, where the sections of blocks were laid at an angle of 48° with the horizontal, there was a tendency for the toe of the lower block to slip ahead, finally producing a concave slope to the transverse section of the superstructure. From the sketch on plate 2 it will be seen that the plane of the foot of the lower row of blocks was at right angles to the face, and in setting the lower blocks supporting rubble-stone was required to be placed under the base of the block. This would naturally leave the block with a tendency to settle outward and finally produce the concave slope described.

At Mormugao there was a slight tendency for the angle of the slope to flatten and become concave at the second or third courses above the base. It will be seen by reference to plate 2 that the lower face of the lower blocks was a compromise between the forms used at Kustendjie and later works.

At Colombo, Madras, and Manora no such tendency towards the slipping of the lower blocks and consequently flattening of the slope is alluded to in the description of these works.

At Colombo the ultimate settlement of the tops of the blocks was from 8 to 18 inches. This was allowed for by keeping the outer end of the work slightly higher when first laid.

At Madras the settlement was from 6 inches to 4 feet, the latter being over a yielding bottom of sand and mud.

At Manora the settlement was excessive, and was from 3 to 4 feet. At this locality the deposition of the rubble mound but slightly preceded the construction of the superstructure, and its settlement was not complete before the superstructure was added. In addition to this the sand bottom yielded to the rubble to an unexpected degree.

At Mormugao the settlement of the superstructure was from 1½ to 2 feet and quite even in extent.

The principle of using sloping blocks arranged in more or less vertical sections independent of each other, was devised to overcome the difficulty adhering to settlement and the resulting dislocation of blocks bonded and arranged in horizontal planes. Again, in the system of ordinary horizontal bond the outer end of the work required to be left in an unfinished condition from the necessity of stepping back the successive courses of masonry on each other. With the system of sloping blocks, the outer end of the work is at all times in a closer and more secure condition.

The sloping block system was first adopted at Manora in 1870, and directly afterward at Kustendjie, then at Madras and Colombo, and lastly at Mormugao in 1880.

Vernon-Harcourt, in discussing the various forms of breakwaters, says: "The mixed system (an upright wall founded upon a rubble mound) will probably have the most extended application; and of all varieties of the type the best appears to be a superstructure founded some 20 feet below low water, upon a simple rubble base, formed of large concrete blocks laid with overhanging cranes upon the sloping block principle, securely connected vertically and horizontally, and capped with concrete-in-mass after settlement has ceased."

A brief allusion may be of interest in this connection to the cases of superstructure, consisting entirely of concrete-in-mass, deposited in frames and forming a monolithic mass.

As applied to breakwaters, this method of construction has been used at Aberdeen on the east coast of Scotland, Fraserburgh and Buckie on the northeast coast of Scotland, Newhaven on the English Channel directly south of London, and at Fiume on the Austrian frontier of the Adriatic Sea.

At Aberdeen South Pier the substructure consisted of blocks of concrete laid as masonry with the ordinary horizontal bond, and carried to a height of about 4 feet above the plane of mean low water. Upon this is reared the superstructure of concrete-in-mass. At Aberdeen North Pier, Fraserburgh, and Newhaven the substructure was formed by 50 to 100 ton bags of concrete deposited from a hopper barge and brought to a height of 3 or 4 feet above mean low water, and upon this the concrete-in-mass superstructure was placed.

At Buckie the breakwater extends to a depth of 10 feet at mean low water. The bottom is rocky and uneven, and the breakwater is entirely of concrete deposited within frames lined with jute cloth.

At Newhaven the substructure consists of 100-ton bags of concrete deposited from hopper barges. This substructure is brought 3 or 4 feet above mean low water, and upon it is reared the superstructure of concrete-in-mass which was deposited in frames. The filling of a section of the frames was commenced at low water and usually carried on ahead of the rising tide.

At Fiume a breakwater was commenced in 1849, whose superstructure was built with concrete-in-mass founded on a rubble mound at a depth of 22½ feet below the water surface. The locality being on an arm of the Adriatic Sea is greatly sheltered. The concrete was deposited in bottomless frames secured to piling and in sections about 31 feet in length. Fiume furnishes the only case of a breakwater consisting of a concrete-in-mass superstructure founded upon a rubble-stone base. In subsequent breakwater extension the plan was modified to that of a simple rubble mound surmounted above high water with a concrete parapet.

At all these localities the breakwaters are used as quays.

The advantages in using concrete-in-mass or in bags are mainly confined to small works which would not justify large expenditure for plant, or to localities where stone is scarce and the foundations are firm.

The disadvantages of the system are, that it is not suitable for irregular settlement; it requires that the locality should be sufficiently sheltered to permit the use of piling and sea staging; it requires the use of larger proportions of cement; it introduces an element of uncertainty as to the character of the concrete below the surface of the water, and it does not permit the utilization of the labor force except at times of comparatively calm weather.

With the exception of Buckie and Fiume breakwaters the concrete-in-mass was laid entirely above the surface of mean low water. The application of such a method of construction to Delaware Breakwater would contain all the disadvantages of the system to a marked extent and without any of its advantages. The separation of the work from the mainland would require the transportation of the freshly made concrete to the work in barges, and with any delay such material would suffer dangerous deterioration. But beyond these disadvantages the rubble mound has been completed, and it would now be impracticable to place the necessary piling for the sea staging and the concrete frame supports.

In setting concrete blocks two methods have been used, viz, from staging, and from cranes. The great advantage possessed by cranes over staging upon exposed sites is, that while the latter must be left exposed to storms, the former can always be run back into shelter. And although the first cost of suitable cranes for handling heavy blocks is quite large, their use dispenses with the great labor, ultimate cost, and delay incident to the use of staging.

The advantage seems so entirely in favor of cranes that they have practically taken the place of staging in modern works. At Kustendjie alone staging was used, but the total length of the breakwater was only 253 linear feet, and the work would not have economically carried any large expenditure for plant.

Composition of concrete blocks at various localities.

Locality.	Cement.	Sand.	Gravel.	Stone.	Proportions.
Aberdeen	1	4	5	.....	1:9
Kustendjie	1	2½	.....	5½	1:8
Manora	1	4	5¾	3¼	1:13
Ymuiden	1	3	5	.....	1:8
Colombo	1	2	.....	6	1:8
Mormugao	1	2	1	6	1:9
Alderney	1	1	4	40*	.....
Wick	1	1	2	4	1:7
Dublin	1	2	5	.....	1:7
Madras	1	2	.....	7½	1:9½

* Per cent.

The parts above used are by volume.

The authority of the best practice in work of this kind seems to be the use of Portland cement for the manufacture of concrete blocks in proportion of about 1 to 8; in which sand occupies two parts, with gravel and 2½-inch broken stones for the remaining six parts. If gravel or clean shingle can not be economically obtained the six parts of broken stone is divided into four parts broken to pass through 2½ to 3½ inch ring, and two parts clean-screened stone broken to three-fourths inch to 1½ inch cubes.

Under Mr. Kyle's experiments at Colombo, concrete blocks of the latter composition, viz, one cement, two sand, six broken stone, gave after three months an average tensile strength of 41 pounds per square inch of section and a crushing strength of 4,231 pounds per square inch of section.

To such a mixture of concrete hard rubble-stone was afterwards added to the extent of about 40 per cent of the entire volume while the material was being placed in the molds. Care was taken that none of this rubble-stone came within 4 inches from the surfaces of the blocks.

At Colombo the molds were removed after three days, and three weeks after the blocks could be set. At Manora the blocks were three to four weeks old. At Mormugao when about three weeks old, and at Kustendjie when two weeks old.

Cost of rubble base and concrete blocks exclusive of cost of plant and superstructure.

Locality.	Length of break-water.	Total cost.	Rubble stone in base.			Concrete blocks.			
			Quantity in gross tons.	Average cost per gross ton.	Cost of leveling per square yard.	Quantity in cubic yards.	Cost of making.	Cost of setting.	Total cost in position.
Colombo	4,212	$2,430,000	320,400	$1.63	$1.80	124,984	$9.57*	.....	$9.57
Madras	7,836	2,402,000	938,100	.86	.....	202,343	3.77	$0.82	4.59
Manora	1,503	529,000	96,700	.86½	3.00	29,180	4.23	1.04	5.27
Mormugao	1,176	426,000	79,500	.59	.75	56,900	4.10	.52	4.62
Aberdeen	1,050	373,500	.....	.....	.....	22,851	3.15	.97	4.12

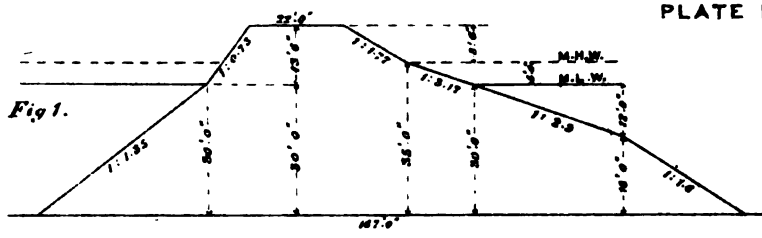
* This price includes the cost of setting.

In connection with the cost of concrete in blocks the cost of concrete in bags and n frames is appended. The prices given as in the case of concrete blocks are exclusive of the cost of plant and superintendence.

Locality.	Proportion of concrete.	Cost in bags.	Cost in frames.
Fraserburgh	1:5 & 1:7	$6.34	$5.06
New Haven	1:8	5.82	5.00
Sand Haven	1:6	.....	4.32
Aberdeen, North pier	1:7	5.05	4.97
Aberdeen, South pier	1:8	6.12	3.90
Wicklow	1:7	.....	4.56

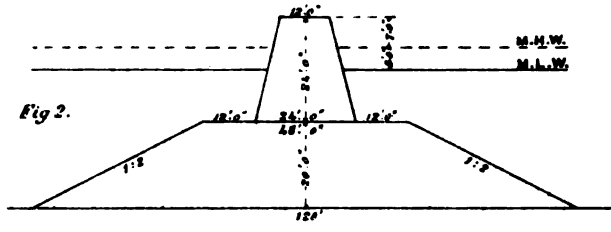
PLATE I.

Fig 1.



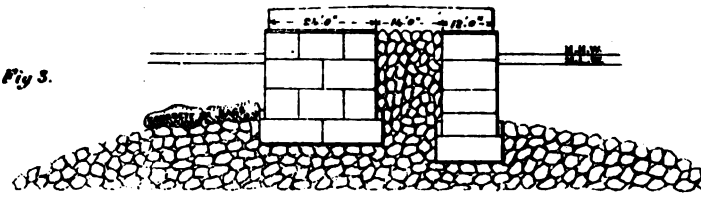
Mean Section of present Breakwater.

Fig 2.



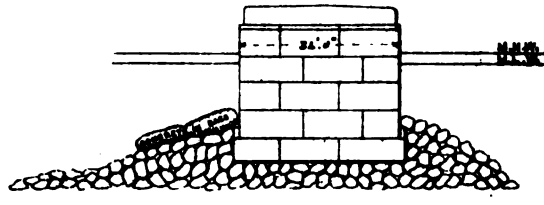
Section of the project of 1862.

Fig 3.



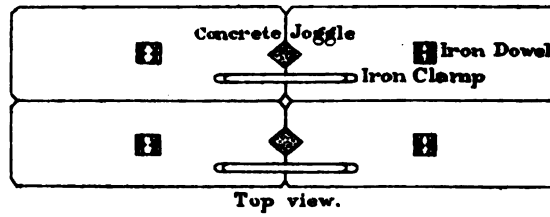
As built for 1300 feet.

Fig 4.



As subsequently built.

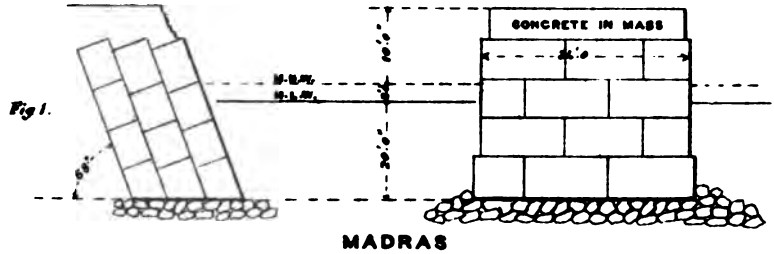
Fig 5.



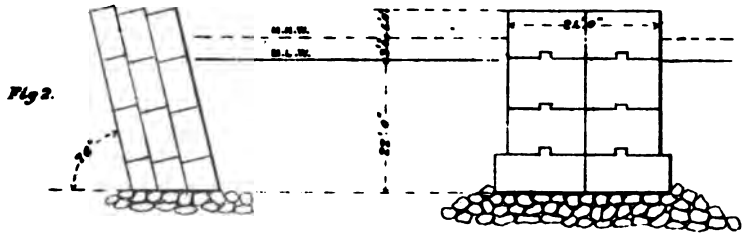
Top view.

PLATE 2.

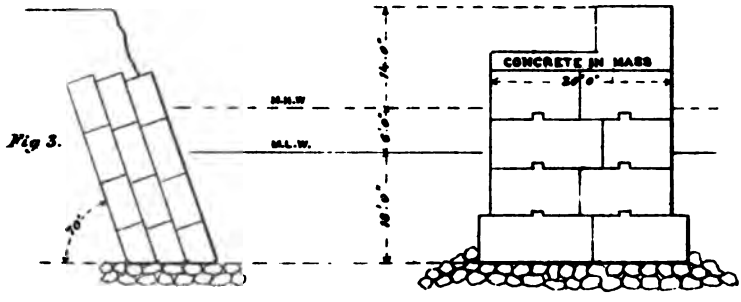
COLOMBO



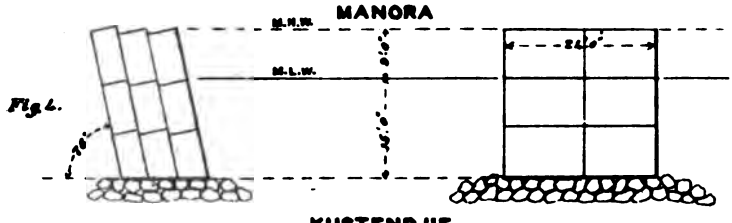
MADRAS



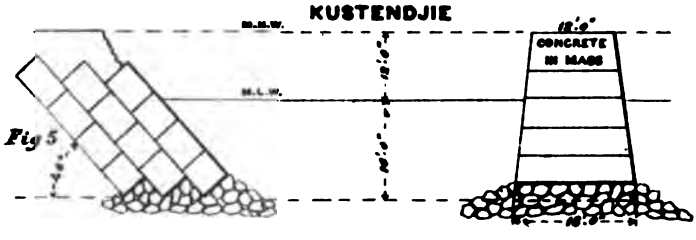
MORMUGAO



MANORA



KUSTENDJIE



No comparison can be fairly made in the cases given between the cost of concrete in blocks and concrete in bags or frames. In the former cases the work was mainly done in India, largely with native labor and the employment of women, and where expensive freight charges had to be added for cement, tools, and machinery. With the latter cases, while the prices for labor may have been higher, the labor was undoubtedly more efficient, and the cost of the concrete was in several cases materially reduced by the use of shingle dredged from the site of the work in the improvement of the harbor.

The entire cost of the works at Colombo was $3,274,000, which includes the dredging of the harbor, foreshore reclamation, shore works, and all expenses of administration. The amount given in the table of $2,430,000 was the cost of the breakwater proper, increased by its proportion of general and administrative expenses. The ordinary labor was furnished by prisoners paid at the rate of 37½ cents per day of eight hours. Cement, tools, machinery, etc., and skilled labor were brought from England. The stone was brought 12 miles by rail.

The cost of the Madras breakwater, $2,402,000, contains the items of $395,000 for preliminary expenses of surveys, railways, buildings and plant, and $150,000 for superintendence.

The cost of the Manora breakwater, $529,000, contains about $75,000 for plant.

The cost of the Mormugao breakwater, $420,000, contains about $20,000 for superintendence and $133,000 for plant and its maintenance.

PROGRESS IN PLACING THE CONCRETE SUPERSTRUCTURE AT LOCALITIES NAMED.

At Colombo one hundred and sixty-six prisoners working eight hours per day were able to make six blocks per day, and three hundred and nine prisoners working twelve hours per day made twelve blocks per day.

The season during which it was possible to lay blocks was about six months, during which an average of one hundred and twenty-five working days were obtained. The average progress of superstructure during these seasons was 900 linear feet or 150 linear feet per month, of superstructure 34 feet wide and from 24 to 28 feet high. The rate of progress would have been somewhat higher if the blocks could always have been on hand. On one occasion 720 tons were set in twelve hours, which was at the rate of one 30-ton block each half hour. The average rate was about 8,000 tons per working month.

At Madras the superstructure, 24 feet wide and 30 feet high, was advanced on the South breakwater at the rate of 990 linear feet per season of six months, and on the north breakwater at the rate of 770 linear feet per season, or about 7,000 tons per month.

At Manora in a season of four months containing ninety-two working days nine hundred and ten blocks, each 27 tons weight, were set, equal to 710 linear feet of breakwater. The average rate per day when work was possible was ten blocks, or 270 tons, per day, or about 6,000 tons per month. The highest rate was eighteen blocks per day, but at one time, under very favorable conditions, six blocks, or 162 tons, were set in one hour and forty minutes. The rate of progress was usually controlled by the rate at which the top of the rubble-mound could be prepared by the divers.

At Mormugao, with dimensions of superstructures of 30 feet wide and 30 feet high, the average rate of progress was 109 linear feet of superstructure per month. It is stated that the progress could easily have been 200 feet per month, or 10,000 tons, if the blocks had been on hand ready to lay.

From the foregoing it seems fair to assume that with the blocks on hand and with suitable appliances for handling them that from 8,000 to 10,000 tons of concrete blocks could be placed in a superstructure each working month.

This rate of progress applied to building a concrete block superstructure at Delaware Breakwater would be equivalent to from 200 to 250 linear feet per month, or the work of constructing 1,350 linear feet could be accomplished in five or six working months.

Trusting that the compilation of facts contained in the foregoing may aid in the determination of the best method of construction to be adopted at Delaware Breakwater,

I am, most respectfully, your obedient servant,

L. Y. SCHERMERHORN,
Assistant Engineer.

Lieut. Col. HENRY M. ROBERT,
Corps of Engineers, U. S. A.

G 8.

IMPROVEMENT OF MANTUA CREEK, NEW JERSEY.

Mantua Creek discharges into the Delaware River at a point about 10 miles below Philadelphia and opposite to Mifflin Bar.

An examination of the creek between its mouth and the village of Mantua, N. J., a distance of about 11 miles, was made in 1881, and in 1882 a project submitted for the improvement of this 11 miles of creek so as to obtain a channel with a low-water depth of 10 feet and width of 80 feet on the lower one-half mile of the creek, decreasing to 4 feet deep and 40 feet wide at Mantua. The estimated cost of obtaining such a channel by dredging was $35,000.

The river and harbor act of August 2, 1882, appropriated $3,000 for the improvement of the creek, but its application was withheld awaiting further appropriations.

Under date of February 27, 1889, the Chief of Engineers directed that a report be made upon the best application of available funds for the improvement of the creek, and what work could be most judiciously undertaken to relieve navigation to the phosphate works, or that part of the creek covering about its lower one-half mile.

A resurvey of this part of the creek was made in May, 1889, and a project submitted June 28, 1889, for the expenditure of available funds by "the formation of a dredged channel 66 feet wide and not less than 8 feet deep at mean low water between the 8-foot curve in the Delaware River and the phosphate works, a distance of about 3,000 feet." This project was approved by the Chief of Engineers, July 2, 1889.

Under an agreement with the American Dredging Company dated July 12, 1889, 20,000 cubic yards of sand and mud were removed at the rate of 13 cents per cubic yard, scow measurement, and deposited behind the Mifflin Bar Dike. By this work a channel was dredged 8 feet deep at mean low water and from 60 to 75 feet wide, extending from deep water in the Delaware River to the phosphate works in the creek.

Available funds were exhausted in the accomplishment of this improvement.

This work is in the collection district of Bridgeton, N. J. Philadelphia is the nearest port of entry, at which the revenue collected during the year ending December 31, 1889, was $22,612,956.17.

Fort Mifflin is the nearest fort, and Tinicum and Fort Mifflin Bar range-lights are the nearest light-houses.

Total appropriations to June 30, 1890	$3,000.00
Total expenditures to June 30, 1890	3,000.00

Money statement.

July 1, 1889, amount available	$2,915.66
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	2,915.66

G 9.

REMOVAL OF WRECKS FROM DELAWARE BAY AND RIVER.

The act of January 23, 1880, appropriated $25,000 for the removal of the wrecks of ten vessels which foundered at Delaware Breakwater Harbor in October, 1877. Eight of these wrecks were removed in

1880, 1881, and 1882, the remaining two disappearing as obstructions to navigation. The act of August 2, 1882, made the balance of the appropriation available for the removal of any wrecks then or thereafter existing in Delaware Bay or River.

In 1886 and 1888 three additional wrecks were removed from the vicinity of Delaware Breakwater Harbor under this appropriation.

During the past fiscal year no wrecks have been removed under this appropriation.

Money statement.

July 1, 1889, amount available	$758.62
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	24.54
July 1, 1890, balance available	734.08

G 10.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

During the fiscal year six wrecks have been removed under the the authority of the act of Congress approved June 14, 1880.

In May, 1889, the *Patriot* was sunk in Delaware Breakwater Harbor in about 5 fathoms of water. The wreck was a dangerous obstruction to vessels entering the harbor.

Under date of August 29, 1889, a contract was entered into with Franklin C. Maull for the removal of this wreck for the sum of $1,295. The work was completed on October 15, 1889.

In September, 1889, four coal barges, the *Tonawanda*, *Wallace*, *Casilda*, and *St. Cloud*, and the bark *Il Salvatore*, were wrecked in the Delaware Bay. Three of the coal-barges sank directly in the Main Ship-Channel, about 4 miles below the Brandywine Shoal light-house, and the fourth upon the outer point of the Shears, about 2 miles north of the breakwater. The bark *Il Salvatore*, after being driven stern foremost through the iron pier at Lewes, Del., sank in the breach formed in the pier.

The wrecks were considered dangerous obstructions to navigation, and their removal was at once undertaken. As it was impossible to definitely connect the names of the four coal-barges with the sites of their wrecks, they were designated as the "north wreck," "east wreck," "west wreck," and "Shears wreck."

Under date of November 30, 1889, a contract was entered into with the Atlantic and Gulf Wrecking Company for the removal of the north wreck for the sum of $3,850. Under date of December 17, 1889, a contract was made with Charles W. Johnston for the removal of the east wreck, west wreck, and the Shears wreck for $4,000, $2,800, and $4,200, respectively. Under date of November 30, 1889, a contract was entered into with Franklin C. Maull for the removal of the *Il Salvatore* for the sum of of $1,749.

Under these contracts the north wreck was removed January 31, 1889, the east wreck May 29, 1890, the west wreck April 29, 1890, the Shears wreck March 26, 1800, and the *Il Salvatore* April 30, 1890.

Abstract of proposals for removal of the wreck of the bark Patriot, lying in Delaware Breakwater Harbor, Del., opened August 21, 1889, by Lieut. Col. Henry M. Robert, Corps of Engineers.

No.	Name and address of bidder.	Price.
1	Joseph D. Truxton, Lewes, Del	$1,490.00
2	Atlantic and Gulf Wrecking Company, Somers Point, N. J	1,450.00
3	Franklin C. Maull, Lewes, Del	1,295.00

Contract (dated August 29, 1889) entered into with Franklin C. Maull.

Abstract of proposals for removal of the wrecks of the coal barges Tonawanda, Wallace, Casilda, and St Cloud, designated as below, and of the bark Il Salvatore, all lying in Delaware Bay, opened November 23, 1889, by Lieut. Col. Henry M. Robert, Corps of Engineers.

No.	Name and address of bidders.	Price for removal.					Amount.
		North wreck.	East wreck.	West wreck.	Shears wreck.	Bark Il Salvatore.	
1	Franklin C. Maull, Lewes, Del	$4,000	$6,000	$3,300	$4,750	$1,749	$20,699
2	Charles W. Johnston, Lewes, Del	6,100	4,000	2,800	4,200	2,275	19,375
3	Atlantic and Gulf Wrecking Company, Somers Point, N. J	3,850	5,900	3,000	4,400	2,300	19,450

No.	Name and address of bidder.	Recommended for acceptance.					Amount.
		North wreck.	East wreck.	West wreck.	Shears wreck.	Bark Il Salvatore.	
1	Franklin C. Maull					$1,749	$1,749
2	Charles W. Johnston		$4,200		$4,200		8,200
3	Atlantic and Gulf Wrecking Company, Somers Point, N. J	$3,850		$3,000			6,850
	Total required for the removal of the five wrecks						16,799.00

1. Contract (dated November 30, 1889), for removal of bark *Il Salvatore* entered into with Franklin C. Maull.
2. Contract (dated December 17, 1889), for removal of "east wreck," "west wreck," and "Shears wreck," entered into with Charles W. Johnston.
3. Contract (dated November 30, 1889), for removal of "north wreck," entered into with the Atlantic and Gulf Wrecking Company.

G 11.

PRELIMINARY EXAMINATION OF ALLOWAY CREEK, NEW JERSEY.

UNITED STATES ENGINEER OFFICE,
Philadelphia, Pa., December 29, 1888.

GENERAL: In compliance with the instructions contained in your letter of September 29, 1888, I have the honor to submit the following report on a preliminary examination of Alloway Creek, New Jersey.

Alloway Creek is a tributary of the Delaware River, its mouth being about 7 miles below Fort Delaware. Its lower portion is very deep, the least depth even at its mouth being over 12 feet at low water,

whereas usually the tributaries of the Delaware have at their mouths very shallow bars. At 10 miles above its mouth, at Quinton, the stream is crossed, just below low water, by a 12-inch cast-iron water-pipe, which carries water to Salem, 4 miles distant, and effectually terminates the further navigation of the stream.

This lower 10 miles of the creek contains 9 bars, carrying less than 6 feet at low water, three of them having in the channel a least depth of 4 feet. The aggregate length of these bars is about 7,000 feet. A cut 100 feet wide with an average depth of 2 feet would give an excellent channel with 6 feet at low water all the way up to Quinton, excepting what is called "the canal," a short cut not 100 yards long, which is deep enough, but should be widened from its present width of 40 feet to 75 or 100 feet. The cost of this improvement should not exceed $20,000.

The present commerce of Alloway Creek amounts to as much as $1,000,000, according to the very full statement of Messrs. Hires & Co., forwarded herewith, two-thirds of the amount being connected with the canning and window-glass factories. The increase of 2 feet in the draught of vessels navigating the stream, which would result from the proposed improvement, would naturally reduce freights and prove a great benefit to commerce. The country tributary to this stream is not supplied with railroad facilities and must depend mainly upon Alloway Creek to get its produce and manufactures to market.

In my opinion, Alloway Creek is worthy of improvement. The least amount required for a survey and report as contemplated by the act of August 11, 1888, I would estimate at $600.

There are forwarded herewith the following papers:

(1) Statistics of commerce furnished by Messrs. Hires & Co.
(2) Copy of Assistant Engineer L. Y. Schermerhorn's report of examination.
(3) Sketch of Alloway Creek.

Very respectfully, your obedient servant,

HENRY M. ROBERT,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. L. Y. SCHERMERHORN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Philadelphia, Pa., December 12, 1888.

COLONEL: I have the honor to submit the following report upon an examination of Alloway Creek, New Jersey, required under the provisions of the river and harbor act of August 11, 1888.

The creek rises in the eastern part of the township of Alloway, Alloway County, N. J., at a point about 25 miles above its mouth, and flowing generally in a southwesterly direction, discharges into the Delaware River at a point nearly opposite the lower end of Reedy Island, or about seven miles below Fort Delaware.

The examination was carried only to the village of Quinton, 10 miles above the mouth, for the reason that just above the bridge at Quinton the stream is crossed by a cast-iron water-pipe which carries the water supply from a pond at Quinton to the village of Salem, distant about 4 miles. This water-main is 12 inches in diameter and its top is barely below mean low water.

At the village of Alloway, which is 4½ miles above Quinton, the creek is crossed by a mill-dam. Even if the water-main at Quinton did not constitute a barrier to the improvement of the creek above Quinton, there is too small an amount of commerce above Quinton to justify any attempt at improving this upper 4½ miles of the stream.

Between the mouth of the creek and Quinton the stream has a low-water width of from 200 to 300 feet. The border land to the creek is generally marsh meadow, indifferently protected from overflow by light dikes. The bed of the creek is composed of mud and sand, the later always occurring in the shallow reaches. There are no

indications of rock or bowlders in any of the shoal area
nation.

The mouth of the creek carries into the Delaware Rive
channel, from 12 to 14 feet deep at mean low water. Th
bar at the mouth of the creek is quite remarkable.

The mean rise of the tide at the mouth of the creek i
Bridge about 5 feet, and at Quinton about 4 feet. This n
the tide is probably caused by the open dikes, which al
volume on the lower reaches of the creek.

The creek is crossed by the three draw-bridges locate
Bridge, 5¾ miles above the mouth; at Hancock's Landing
and at Quinton, 10 miles above the mouth. These draw
ample openings, and are in good repair and easily ope
bridge at Hancock's Landing is rather unfortunately chos
at an abrupt bend where shoal areas occur both above a
shoal above the bridge, as subsequently described, is
obstructions to navigation, and the difficulty of passing t
proximity to the draw-span of the bridge.

Although these bridges are provided with suitable d
with regular bridge-tenders. The operation of the Hanc
plished by a tender employed by parties interested in t
river in her trips between Philadelphia and Quinton.
Landing is without a tender and vessels are obliged to tie
so as to either permit some of the crew going ashore to
to obtain such service from some chance passer-by. Upon
others throughout the country, this lack of bridge-tend
with draws which require to be frequently opened is a v
struction to navigation.

The village at Hancock's Bridge, 5¾ miles above the
about 200. It has one or more canning factories, is provide
forms the shipping center for the settlements at Hagerst
and quite a large contiguous country. The village of
mouth, has a population of about 800. It has several c
glass-works, and is the center of a thriving and well-c
The nearest railroad to the villages of Quinton and H
Railroad, at Salem, N. J., which is from 4 to 5 miles distar

The existence and location of the obstructions to navig
shown on the accompanying sketch were determined by
steam yacht *Mermaid* at about high water and without
creek and a return trip on a rising stage of the tide under
Padgett, who for many years has sailed a tug-boat betwee
and who was thoroughly familiar with all the shoals of t
made along the channel about 100 feet apart, and their p
points on the sketch and river. Whenever the statemen
of the soundings indicated shoal areas their general positio
located by the configuration of the banks of the creek.
marks along the banks the soundings could be reduced
proximation.

The opinion of those interested in the improvement of
6-foot low-water channel would meet all present requir
results of the examination indicate that such a channel c
by a comparatively small expenditure, but that any mat
depth would require an expenditure entirely disproportion

The following statement shows the location and exten
termined by this examination:

Location.	Length of shoal between 6-foot curves.	Minimum low-water depth.	A
Above station:	*Feet.*	*Feet.*	
3½ miles	500	4.0	
4¼ miles	300	4.7	
5 miles	900	4.5	
6¼ miles	1,200	4.0	
6½ miles	700	5.3	
6⅞ miles	300	4.7	
7 miles	800	5.5	
7½ miles	1,200	4.0	
7¾ miles	900	5.0	

The shoals at "The Square," "Above Canal," and at "Second Bridge" (Hancock's Landing) are those which are most complained about and which this examination indicates as carrying the least water.

The cut-off just above Hancock's Bridge, known as the "Canal," has a width of about 40 feet and a low-water depth of from 11 to 12 feet. This canal has resulted from a shallow artificial ditch made some years ago, which quickly enlarged to its present dimensions. The parts of the creek which were cut off by the canal have materially shoaled, and the throttled section of the creek at this point acts as a barrier to the free movement of the tidal volume. To correct this evil, and to give vessels a sufficiently wide channel to pass each other at this locality, the canal should be widened to 100 feet, if the improvement of the creek is undertaken.

To reach an approximate estimate of the probable cost of improving these shoal areas so as to afford a channel 75 feet wide and 6 feet deep at mean low water, it may be assumed that the excavation will average 2 feet deep for an aggregate distance of about 7,000 feet, which would require the removal of about 50,000 cubic yards of material; if the channel width be assumed as 100 feet it would require the removal of about 70,000 cubic yards, scow measurement.

If the widening of the canal to a width of about 100 feet and to a depth of 6 feet at mean low water over the widened area be adopted as part of the improvement of the creek, it will add about 10,000 cubic yards to the foregoing estimates of quantities. The material dredged from the shoal areas of the channel should be deposited in the old channels at the canal.

If the commercial importance of Alloway Creek is deemed sufficient to justify its improvement, a systematic survey should be made of the parts of the creek where an improved channel is necessary. These localities can be quite exactly determined by a running examination, which can comprehensively pass over those parts where no improvement is required, and in so doing determine the shoal areas. Detailed surveys of those shoal areas can be then made as they are successively reached. By this plan, at a cost not exceeding $600, all surveys can be made which are necessary for forming a definite plan of improvement and a reliable estimate of its cost.

Very respectfully, your obedient servant,

L. Y. SCHERMERHORN,
Assistant Engineer.

Lieut. Col. HENRY M. ROBERT,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

DECEMBER 1, 1888.

We herewith submit for your information a statement of the business done and depending upon the stream known as Alloway Creek, being an approximate estimate of $1,050,200.

The number and kind of vessels navigating the creek are, one steam-boat making two trips weekly, two sloops, ten schooners, fifteen barges, tugs, boats.

The maximum draught of boats is 7½ feet.

The kind, quantity, and value of shipments are specified as follows:

Shipments.		Quantity.	Value.
Into the creek:			
Coal	tons	12,000	$42,000
Soda ash	do	500	13,000
Sand	do	2,000	3,000
Lime (for manufacturing purposes)	do	400	2,400
Fertilizers	do	800	20,000
German clay	do	100	1,500
Lumber (for manufacturing purposes)	feet	2,000,000	25,000
Lumber (for building purposes)	do	1,000,000	25,000
Tin plates for cans	boxes	20,000	100,000
Solder	tons	70	22,000
Labels for cans			10,000
Oyster-shells	bushels	120,000	4,800
Lime (for fertilizing)	do	20,000	1,500
Merchandise, general store	do		200,000
			470,200
Out of the creek:			
Window-glass	boxes	60,000	150,000
Canned goods	do	175,000	350,000
Ship-timber	feet	125,000	5,000
Grain and farm produce	bushels	100,000	75,000
			580,000

the bar by a distance of about 400 feet. The abru
which is required in crossing the bar has given
it bears.

The improvement of the Square can be best ac
ing a channel across the bar and constructing a
500 feet long extending obliquely from the left
wards the deep-water channel below the bar. Su
the ebb currents from their present path along t
centrate them upon the dredged channel across t

The dike should be formed of the material
across the bar, its channel slope being afterwa
wash by a facing of stone about one foot in thickn
the dike could be used as a dumping basin for
dredged from the bar not required for the con
Such a dike could probably be built for less than

The "Canal," which is about one-half mile abo
cock, is an artificial cut-off about 200 feet in leng
ago, by which the creek at this point was shorte
mile. This canal is about 50 feet wide between i
carries a depth of from 6 to 7 feet in a channel a

Besides the difficulties arising from the use of
wide, the creek is throttled by this reduction in it
tent as to materially diminish the tidal volume
of the stream above the canal. Any plan for th
loway Creek should, in addition to the formatio
point 6 feet deep and 75 feet wide, provide for the
to about 150 feet between the low-water lines,
mal low-water width of the creek in the vicini
would require the removal of about 8,000 cubic ya
amount has been provided for in the foregoing e

At Upper Hancock Bridge the obstruction
partly in the shoal areas just above the bridge, a
itself. This bridge is so located across the creek
proximity to an abrupt turn in the creek which
upon the side of the creek opposite to the side cov
of the bridge. This inconvenient position of the
and at the bend above, forces vessels in passing
abruptly from one side of the creek to the other,
are obliged to wait for the opening of the draw,
the unfortunate location of the bridge becomes s

Between the mouth of Alloway Creek and
crossed by three bridges provided with draws of
sions:

Hancock Bridge clear draw-span .....
Upper Hancock Bridge clear draw-span .....
Quinton Bridge clear draw-span .....

These bridges, although provided with suitabl
vided with regular bridge-tenders. The draw at
used, since only a small amount of commerce pa
But during the season of navigation the Hancoc
to be opened several times each day.

When this service is required, vessels desiring
either tie up at an adjacent landing, so as to per
open the draw, or they must depend upon som
perform the service for them. This method of h

the draw is particularly embarrassing at the Upper Hancock Bridge, where the location of the bridge and the direction of the channel approach thereto makes it very difficult to stop the vessel until the draw can be opened by one of the vessel's crew. If Alloway Creek is to be improved, some better provision should be made for the proper handling of the draw-bridges.

PLAN AND ESTIMATE.*

The plan of improvement which has been indicated may be summarized as follows: The formation by dredging of a channel 6 feet deep at mean low water and 60 feet wide from Quinton to a point about 1,000 feet above the Upper Hancock Bridge; from thence a channel of the same depth and at least 75 feet wide down the stream to the lower side of the Square. At the Canal, in addition to obtaining a channel of the dimensions named, the width of the creek is to be increased to about 150 feet between its low-water lines. At the Square the dredged channel is to be supplemented by a deflecting dike about 500 feet in length, formed of the dredged material, with its channel-face protected by a covering of stone 1 foot thick.

I would estimate the cost of this plan of improvement as follows:

100,000 cubic yards of dredging, at 20 cents	$20,000
500 linear feet of dike	1,500
Contingencies and superintendence	3,500
	25,000

This estimate is based upon appropriations of not less than $12,000 at a time. With small appropriations the cost would exceed the above estimate. It would be far better if the entire $25,000 was appropriated at one time.

The general commercial statistics of Alloway Creek are given in the report of the examination under date of December 29, 1888.

There are transmitted by this mail, in a separate package, four tracings * covering that part of the creek which requires improvement.

Very respectfully, your obedient servant,

HENRY M. ROBERT,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

* Omitted.

the bar by a distance of about 400 feet. The abrupt change in direction which is required in crossing the bar has given this locality the name it bears.

The improvement of the Square can be best accomplished by dredging a channel across the bar and constructing a deflecting dike about 500 feet long extending obliquely from the left bank of the creek towards the deep-water channel below the bar. Such a dike would divert the ebb currents from their present path along the left bank and concentrate them upon the dredged channel across the bar.

The dike should be formed of the material dredged from the cut across the bar, its channel slope being afterwards protected against wash by a facing of stone about one foot in thickness. The area behind the dike could be used as a dumping basin for any excess of material dredged from the bar not required for the construction of the dike. Such a dike could probably be built for less than $1,500.

The "Canal," which is about one-half mile above the village of Hancock, is an artificial cut-off about 200 feet in length, formed many years ago, by which the creek at this point was shortened more than one-half mile. This canal is about 50 feet wide between its low-water lines and carries a depth of from 6 to 7 feet in a channel about 25 feet wide.

Besides the difficulties arising from the use of a channel only 25 feet wide, the creek is throttled by this reduction in its width to such an extent as to materially diminish the tidal volume passing to the reaches of the stream above the canal. Any plan for the improvement of Alloway Creek should, in addition to the formation of a channel at this point 6 feet deep and 75 feet wide, provide for the widening of the canal to about 150 feet between the low-water lines, which is the least normal low-water width of the creek in the vicinity of the canal. This would require the removal of about 8,000 cubic yards of material, which amount has been provided for in the foregoing estimates of quantities.

At Upper Hancock Bridge the obstruction to navigation consists partly in the shoal areas just above the bridge, and partly in the bridge itself. This bridge is so located across the creek as to place it in close proximity to an abrupt turn in the creek which carries its best water upon the side of the creek opposite to the side covered by the draw-span of the bridge. This inconvenient position of the channels at the bridge and at the bend above, forces vessels in passing this locality to haul abruptly from one side of the creek to the other, and when such vessels are obliged to wait for the opening of the draw, as is usually the case, the unfortunate location of the bridge becomes strongly manifest.

Between the mouth of Alloway Creek and Quinton the stream is crossed by three bridges provided with draws of the following dimensions:

	Feet.
Hancock Bridge clear draw-span	54
Upper Hancock Bridge clear draw-span	42½
Quinton Bridge clear draw-span	48

These bridges, although provided with suitable draws, are not provided with regular bridge-tenders. The draw at Quinton is but seldom used, since only a small amount of commerce passes above that point. But during the season of navigation the Hancock bridges are required to be opened several times each day.

When this service is required, vessels desiring to pass the draw must either tie up at an adjacent landing, so as to permit one of the crew to open the draw, or they must depend upon some chance passer-by to perform the service for them. This method of having no attendant to

the draw is particularly embarrassing at the Upper Hancock Bridge, where the location of the bridge and the direction of the channel approach thereto makes it very difficult to stop the vessel until the draw can be opened by one of the vessel's crew. If Alloway Creek is to be improved, some better provision should be made for the proper handling of the draw-bridges.

PLAN AND ESTIMATE.*

The plan of improvement which has been indicated may be summarized as follows: The formation by dredging of a channel 6 feet deep at mean low water and 60 feet wide from Quinton to a point about 1,000 feet above the Upper Hancock Bridge; from thence a channel of the same depth and at least 75 feet wide down the stream to the lower side of the Square. At the Canal, in addition to obtaining a channel of the dimensions named, the width of the creek is to be increased to about 150 feet between its low-water lines. At the Square the dredged channel is to be supplemented by a deflecting dike about 500 feet in length, formed of the dredged material, with its channel-face protected by a covering of stone 1 foot thick.

I would estimate the cost of this plan of improvement as follows:

100,000 cubic yards of dredging, at 20 cents	$20,000
500 linear feet of dike	1,500
Contingencies and superintendence	3,500
	25,000

This estimate is based upon appropriations of not less than $12,000 at a time. With small appropriations the cost would exceed the above estimate. It would be far better if the entire $25,000 was appropriated at one time.

The general commercial statistics of Alloway Creek are given in the report of the examination under date of December 29, 1888.

There are transmitted by this mail, in a separate package, four tracings * covering that part of the creek which requires improvement.

Very respectfully, your obedient servant,

HENRY M. ROBERT,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

* Omitted.

APPENDIX H.

IMPROVEMENT OF HARBORS AND RIVERS IN THE STATES OF DELAWARE AND MARYLAND, AND OF MAURICE RIVER, NEW JERSEY, AND THE INLAND WATER-WAY FROM CHINCOTEAGUE BAY, VIRGINIA, TO DELAWARE BAY.

REPORT OF WILLIAM F. SMITH, UNITED STATES AGENT, MAJOR OF ENGINEERS, RETIRED, IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1890, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Maurice River, New Jersey.
2. Wilmington Harbor, Delaware.
3. Ice Harbor at New Castle, Delaware.
4. Duck Creek, Delaware.
5. St. Jones River, Delaware.
6. Mispillion Creek, Delaware.
7. Broadkin River, Delaware.
8. Inland water-way from Chincoteague Bay, Virginia, to Delaware Bay, at or near Lewes, Delaware.
9. Broad Creek, Delaware.
10. Susquehanna River above and below Havre de Grace, Maryland.
11. Fairlee Creek, Maryland.
12. Corsica Creek, Maryland.
13. Choptank River, Maryland.
14. Harbor at Cambridge, Maryland.
15. Removing sunken vessels or craft obstructing or endangering navigation.

EXAMINATIONS AND SURVEYS.

16. Appoquinimink Creek, Delaware.
17. Wicomico River, Maryland.
18. North East River, Maryland.
19. Chester River between Crumpton and Jones's Landing, Maryland.
20. Manokin River, Maryland.
21. Elk River, Maryland.
22. Onancock Harbor, Virginia.
23. Harbor of Cape Charles City and approaches by Cheuton Inlet, Virginia.
24. Chincoteague Inlet, Virginia.

UNITED STATES ENGINEER OFFICE,
Wilmington Del., July 9, 1890.

GENERAL: I have the honor to transmit herewith the annual report of the works of river and harbor improvement in my charge for the fiscal year ending June 30, 1890.

I was assisted during the year by Mr. A. Stierle, assistant engineer, in the prosecution of these works.

Very respectfully, your obedient servant,

WM. F. SMITH,
United States Agent.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers U. S. A.

H 1.

IMPROVEMENT OF MAURICE RIVER, NEW JERSEY.

As stated in my last annual report, the appropriation of $10,000 made by the act of August 11, 1888, was still unexpended at the close of the fiscal year ending June 30, 1890, owing to the high prices then prevailing for dredging.

The work had previously been advertised, and as the lowest bid received was 30 cents per cubic yard, scow measurement, or 16 cents higher than the price paid in 1887 for dredging in the same locality and which was measured in this place, it was deemed advisable to withhold the money for better prices. In December, 1889, the authority of the Chief of Engineers was obtained to have the work done in open market. Of two offers received, that of the American Dredging Company, viz, 15 cents per cubic yard removed and measured in place, was the lowest. They are now engaged in dredging the river, and the the work under the present appropriation will be completed in July, 1890.

The available funds are to be expended in widening the channel near Millville and in deepening it wherever necessary.

Operations were commenced on May 6, 1890, and up to the close of the fiscal year 49,918 cubic yards of material had been removed from the channel.

The original project was for a low-water channel 100 feet wide and 6 feet deep from the town of Millville to a point about 4 miles below, where the natural and continuous 6-foot depth is found, and for a 4-foot channel along the wharves in the town named.

Up to the close of the fiscal year ending June 30, 1890, the sum of $28,816.83 had been expended, and the projected channel has been extended the full width and depth to 1,000 feet above the bridge at Millville.

It is proposed to continue the improvement of the channel with the amount asked for by extending it to the head of navigation, if sufficient funds are appropriated.

This work is in the collection district of Bridgeton, N. J., which is also the nearest port of entry.

The amount of revenue collected there during the fiscal year ending June 30, 1890, was $76.62.

AMOUNTS APPROPRIATED.

By act passed August 2, 1882	$3,000
By act approved July 5, 1884	17,000
By act approved August 5, 1886	5,000
By act of August 11, 1888	10,000

Money statement.

July 1, 1889, amount available		$9,991.07
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$3,807.90	
July 1, 1890, outstanding liabilities	4,204.77	
		8,012.67
July 1, 1890, balance available		1,978.40
Amount appropriated by act of September 19, 1890		8,000.00
Amount available for fiscal year ending June 30, 1891		9,978.40

Amount (estimated) required for completion of existing project	69,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	20,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Receipts.

Classification.	Weight.	Value.
	Tons.	
Raw products: Coal, pig-iron, ship-timber, ice, cotton	27,630	$327,000
Manufactured products: Bricks, fertilizers, and sawed lumber	7,775	67,700
Agricultural products: Grain and hay	4,471	90,400
General merchandise	100	4,000
	39,376	489,200

Shipments.

Classification.	Weight.	Value.
	Tons.	
Raw products: Cordwood, sand, clay, and gravel	63,800	$106,325
Manufactured products: Iron pipe and lumber	12,600	376,000
Agricultural products: Hay	200	2,000
	76,660	484,325

Total tonnage, 115,976 tons. There was no increase since last report.

Vessels sailing and trading in Maurice River, New Jersey.

Class of vessels.	No.	Aggregate tonnage.	Draught.	Trips.
			Feet.	
Freight steamers	3	Not given.	8	One monthly; two from seven to eight trips per year.
Tug-boats	1	16	.....	Once or twice per month and weekly.
Schooners	22	1,621	4 to 10	

Vessels built and repaired during the year.

	No.	Registered total tonnage.	Draught when leaving shipyard.	Calculated maximum draught when loaded.
			Feet.	*Feet.*
Built:				
Schooners	1	484	7½	16
Repaired:				
Steam-barge	1	150	.....	.....
Sailing vessels	47	470	.....	.....
Schooners	5	.....	.....	.....

H 2.

IMPROVEMENT OF WILMINGTON HARBOR, DELAWARE.

At the beginning of the past fiscal year advertisements had been published for proposals for dredging a 15-foot low-water channel 150 feet wide between the Delaware River and Market Street Bridge, under the appropriation of $30,000 made by act of August 11, 1888. Bids were opened July 29, and the contract was awarded to the lowest bidder, the National Dredging Company of Wilmington, Del., the price being

13.9 cents per cubic yard, measured in scows. Operations were commenced on August 26 and ended on December 9, 1889. The amount of material removed from the channel was 165,214 cubic yards, principally mud, sand, and gravel. The channel dredged extended from the 15-foot curve in the Delaware River to the Shellpot Bridge of the Philadelphia, Wilmington and Baltimore Railroad across the Christiana River, a distance of 7,200 feet. This section was dredged to the full proposed width of 150 feet. From the bridge and through the north draw of it another cut 80 feet in width was dredged in an up-river direction for a distance of 900 feet, until it intersected and led into the main channel above.

The repairs to the jetty at the mouth of the Christiana River which were found necessary at the beginning of the past fiscal year were delayed at that time on account, as then stated, of a stringency in the lumber market for large-sized timber. Authority had been obtained to do the work by day's labor and to purchase material in open market. Upon making a close examination, however, it was found that during the delay additional damage had been done and that the repairs would have to be made upon a larger scale, and proposals were invited to do the work by contract. Of two bids received that of Mr. Ira Lunt, of New Castle, Del., was the lowest, and the contract was awarded to him. He commenced the repairs September 27 and finished October 20, 1889. The work embraced the removal of 370 linear feet of face timber, 77 cross-ties, 147 running feet of sheet-piling with 53 walling strips, 38 braces and caps, and 116 planks in the board walk. There were used in addition 300 cubic yards of large stone for filling into the cribs and 132 cubic yards of riprap on the south face of the outer end of the jetty. The cost of the repairs was $1,463.67. The amount expended during the fiscal year ending June 30, 1890, is $27,129.21.

The condition of the channel above the section dredged last year is not exactly known at this date, as no examination has been made since September, 1888.

At that time it was found that the channel dredged in 1887 had shoaled considerably between the Market Street Bridge and Third Street Bridge, and also for a short distance opposite the mouth of the Brandywine Creek. The shoaling below the latter point reported at the same time was removed by the recent dredging.

The approved project of improvement for this harbor embraces a 15-foot low-water channel 150 feet wide from the entrance into the Delaware River to the Rolling-Mill Wharf, 4,750 feet above present end of the jetty; 100 feet wide from this wharf to the Delaware and Western Railroad Bridge; and 75 feet wide from this bridge to the Pulp Works; also a channel 12 feet deep at mean low water and 50 feet wide from the Pulp Works to the Delaware Railroad Bridge, and the construction of a jetty at the mouth of the Christiana River. This project was recommended by a Board of Engineers in 1881, and its cost estimated at $175,551.

The construction of the jetty and dredging operations in accordance with this project were commenced in the following year.

On page 622 of the Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1883, is printed a revised estimate for the completion of this project. This estimate apparently increases the channel-width of the whole section to be improved between the Rolling-Mill Wharf and the Pulp Works to 150 feet, and makes no provision for a 12-foot channel from the Pulp Works to the Delaware Railroad Bridge, as originally contemplated. The total cost of the work in the harbor, exclusive of the cost of the jetty, which was then nearly fin-

ished, and inclusive of the changes made in the width and length of the proposed channel, is therein placed at $101,384.

The project for the jetty was modified in 1884, providing for an additional height of 4 feet and an extension of 322 feet in the length.

Previous to the adoption in 1881 of the present project the harbor had been improved under a project made in 1871 for a 12-foot channel between 100 and 200 feet wide from the mouth to the city of Wilmington. Under this project, which was reported completed in 1881, the sum of $83,000 had been expended.

Before the year 1871 the Government had also at various times expended $32,500 in improving the navigable channel of the Christiana River, and since the present project was adopted additional appropriations of $173,750 have been made. The total amount appropriated by the United States for the improvement of Wilmington Harbor is therefore, at the end of the fiscal year, $289,606.

The obstructions to a permanent improvement of the harbor are detailed in a report submitted to the Department under date of February 19, 1889, accompanied by a map of the survey made in September, 1888.

It is recommended that before any further appropriations are expended a new project be made and submitted for approval, including the condition of the channel as affected by the new railroad bridge below the mouth of the Brandywine Creek, a change in the currents of the latter stream at its mouth, the removal of rock from the channel of Christiana River, the extension of the jetty, and the imposition of certain obligations upon the State or municipal authorities having limited jurisdiction in these waters.

An appropriation of $100,000 is recommended for the fiscal year ending June 30, 1892, to be expended under a modified project.

Wilmington is a port of entry and in the collection district of Delaware. The amount of revenue collected during the fiscal year ending June 30, 1890, is $6,536.10.

AMOUNTS APPROPRIATED.

By act approved—		By act approved—	
July 14, 1836	$15,000	June 18, 1878	$7,000
March 3, 1837	8,000	March 3, 1879	3,500
July 7, 1838	9,356	June 4, 1880	10,000
July 11, 1870	15,000	March 3, 1881	50,000
June 10, 1872	10,000	By act passed August 2, 1882	50,000
March 3, 1873	6,000	By act approved—	
June 23, 1874	6,000	July 5, 1884	25,000
March 3, 1875	10,000	August 5, 1889	18,750
August 4, 1876	16,000	By act of August 11, 1888	30,000

Two thousand four hundred and eleven dollars and twenty-two cents of the above appropriations have been carried to the surplus fund of the Treasury.

Money statement.

July 1, 1889, amount available	$29,964.77
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	27,129.21
July 1, 1890, balance available	2,835.56
Amount appropriated by act of September 19, 1890	30,000.00
Amount available for fiscal year ending June 30, 1891	32,835.56
Amount (estimated) required for completion of existing project	87,634.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	87,634.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals received and opened by General Wm. F. Smith, United States Agent, July 29, 1889, for dredging in Wilmington Harbor, Delaware.

No.	Name and address.	Time.		Price per cubic yard, scow measurement.
		Commence.	Complete.	
		1889.	1889.	*Cents.*
1	Atlas Dredging Company, Wilmington, Del	Aug. 15	Dec. 31	14
2	National Dredging Company, Wilmington, Del	At once	Dec. 31	*12.9
3	Frank C. Somers, Camden, N. J	Aug. 20	Nov. 30	14½
4	American Dredging Company, Philadelphia, Pa	At once.	Dec. 25	15

* Recommended for acceptance and contract awarded.

Abstract of proposals received and opened by General Wm. F. Smith, United States Agent, September 3, 1889, for repairing jetty at mouth of Christiana River, Wilmington Harbor, Del.

No.	Name and address.	Prices of material in place.						Approximate total of bids.
		Timber, per foot, B. M.	Rag-bolts, per pound.	Screw-bolts, per pound.	Spikes, per pound.	Stone for refilling.	Stone for rip-rap.	
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Per cu. yd.*	*Per cu. yd.*	
1	Geo. C. Platt, Philadelphia, Pa	4	4	6	5	$2.00	$1.35	$1,682.80
2	Ira Lunt, New Castle, Del	2.4	4½	4½	4½*	1.48	1.35	1,218.00

Contract with Ira Lunt.

COMMERCIAL STATISTICS.

Vessels sailing in and out of Wilmington Harbor, Del.

Class of vessel.	No.	Aggregate tonnage.	Draught.	Trips.
			Feet.	
Passenger steamers	3	644	6½ to 8½	Twice a day each.
Freight steamers	6	1,517	7 to 8	Daily and weekly.
Tug-boats	5	223	4 to 8	
Schooners	14	4,267	4 to 12	Constantly.

This list was compiled from data furnished by only a few of the shipping firms and vessel-owners of Wilmington, and is therefore not complete.

Vessels built and repaired at Wilmington, Del., during the year 1889–'90.

Classes of vessel.	No.	Registered total tonnage.	Draught of largest vessel when leaving shipyard.	Calculated maximum draught when loaded of largest vessel built.
			Feet.	*Feet.*
Built:				
Passenger steamers	7	4,365	10½	17
Freight steamers	2	100	6	.....
Passenger and freight steamers	4	648	7½	.....
Government steamers *	2	1,897	.....	.....
Towing steamers	1	75	7	.....
Car-floats, scows, and dredging-machines	8	2,950	.....	.....
Schooners	4	3,475	9	19
Repaired:				
Steamers	65	18,167	.....	.....
Sailing vessels	72	11,090	.....	.....
Barges	6	1,395	.....	.....

* One revenue-cutter; one monitor, Amphitrite.

These data were kindly furnished by the following ship-building firms: The Harlan & Hollingsworth Company, The Jackson & Sharp Company, The Pusey & Jones Company, and Enoch Moore.

The volume of the maritime business remains about the same as reported last year, viz: 952,000 tons, valued at $16,000,000.

H 3.

ICE-HARBOR AT NEW CASTLE, DELAWARE.

The appropriation of $7,500 made by the act of August 11, 1888, is still being withheld until another appropriation is made; both are to be applied, if the amount is sufficient, in rebuilding Pier H.

An examination of the ice-piers in the harbor was made, with the assistance of a diver, in May, 1890. The number of piers examined was seven. Three of these piers (B, H, and K) are located at the upper end of the harbor, along a line normal to the shore, and are about 120 feet apart. Two (I and L) are located at the lower end of the harbor, and are disposed in a similar manner. The distance between the upper and lower line of piers is about 900 feet. On the longer, or offshore side, the harbor is protected against the influx of ice by two piers (M and N) 400 feet apart and upon a line 400 feet from and parallel with low-water line on shore. The area inclosed thus forms a somewhat elongated half of an octagon, containing about 8 acres. Piers B and I are square in plan; the rest are hexagonal, the longest axis in direction parallel with the currents. All piers have a crib-foundation, filled with rubble, and extending to the plane of mean low water, upon which rests the superstructure, about 12 feet high, consisting of cut dimension stone and rubble hearting.

Pier B, built in 1803, was found to be considerably abraded on the corners of the crib, especially on the up-river side. Pier H, built in 1832, suffered from like causes and to a greater degree. At one corner the projecting ends of two succeeding courses of the timber have been broken off for a length of 2 feet, causing the superstructure immediately above that point to settle 3 inches. The other corners of the pier have also settled, but not as much. On pier K, built in 1874, one of the top courses of the crib on the southeast side is broken off for a length of 6 feet, the piece being pushed into the crib. Pier M, built in 1879, was found in fair condition. The same is to be reported of Pier N, which was built in 1882, and of L, which was built in 1875. Pier I, which dates back to 1854, shows as yet no defects or weak points. The vertical oak sheathing which has been placed against the sides of the crib at the height of low water is partially gone on three sides and wholly on one side, the pier being a square one. It may be said generally that all the piers show the effects of the cutting and friction of passing ice in a greater or less degree at about the plane of mean low water, that is, near the top of the crib. The wooden or iron sheathing, with which all are fortified at that height, is generally soon torn off or cut in two, and the scarf ends of the crib-timbers remain exposed to collisions with vessels and to the action of floating ice, and consequently other bad results follow. The examination clearly shows that the weakest point in each ice-pier is at the corners of the cribs, where destruction will begin unless arrested in time.

A survey of the harbor was made after the ice-piers had been examined, embracing the hydrography of the river for about 1,800 feet above

and below the harbor and from the shore to mid-channel or deep water in the Delaware River. The plotted results show that the area dredged in 1887 has filled up again to the original depth that existed before the dredging was commenced. The contours of the bottom to-day are almost identical with those of the survey of 1879. In other words, the excavation made by dredging into the shelving shore, not having been followed by any relative increase in the currents, was gradually destroyed again by the prevailing forces which tend to build this shore. It would appear, therefore, that under present conditions periodical dredging will always be necessary to maintain a depth of 12 feet or more close up to the wharves.

The project for the establishment of an ice-harbor at New Castle dates back to colonial times, and was suggested by the necessity of providing a place of refuge for vessels during the prevalence of ice in the Delaware River. Since the ice-harbor at Reedy Island, 10 miles below, has become useless this harbor is the first one reached by vessels coming up the bay, and its importance to navigation may be inferred from the fact that as many as 2,000 vessels seek refuge here during the winter when the ice is unusually heavy.

In its present condition the enlargement of the harbor is only a question of time. The insecure state of pier H affords an opportunity to increase the sheltered area to some extent by removing it and rebuilding it some distance farther up the river, nearly on a line with piers M and K. In addition, another pier built on the 30-foot curve inside of the intersection of two lines prolonged off shore from piers K and M, and L and N, respectively, would materially increase the protected area of the harbor.

It is proposed to expend the balance of the funds now available and the amount asked for, if appropriated, in rebuilding pier H.

The ice-harbor of New Castle is in the collection district of Delaware; Wilmington is the nearest port of entry, and the amount of revenue collected there during the fiscal year ending June 30, 1890, was $6,536.10.

AMOUNTS APPROPRIATED.

By act approved—		By act approved—	
May 20, 1826	$25,000.00	March 3, 1875	$20,000.00
March 2, 1829	18,895.99	August 14, 1876	12,000.00
July 2, 1836	25,000.00	June 18, 1878	10,000.00
March 3, 1837	10,000.00	March 3, 1879	5,500.00
July 7, 1838	11,573.00	June 14, 1880	3,000.00
August 30, 1852	15,000.00	March 3, 1881	20,000.00
July 15, 1870	2,500.00	July 5, 1884	2,000.00
June 10, 1872	27,000.00	August 5, 1886	5,000.00
March 3, 1873	20,000.00	By act of August 11, 1888	7,500.00
June 27, 1874	10,000.00		

Of the above the sum of $18,285.05 has been carried to the surplus fund of the Treasury.

Money statement.

July 1, 1889, amount available	$7,500.00
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	153.56
July 1, 1890, balance available	7,346.44
Amount appropriated by act of September 19, 1890	8,100.00
Amount available for fiscal year ending June 30, 1891	15,446.44

H 4.

IMPROVEMENT OF DUCK CREEK, DELAWARE.

There were no operations during the fiscal year ending June 30, 1890.

The appropriation of $10,000 of August 11, 1888, was expended during the fiscal year ending June 30, 1889, in dredging a continuous channel not less than 40 feet wide and 6½ feet deep at mean low water between Brick Store Wharf and Smyrna Landing, and in making a turning basin at the latter place of a sufficient size to permit a steamer 150 feet in length to turn with ease.

The improvement of this stream is based upon a survey made in 1887. The project submitted embraces the making of a 7-foot low-water channel 60 feet wide from Smyrna Landing to the mouth, and 100 feet wide across the bar at the mouth, the channel across the bar to be protected by a stone jetty, the total cost of the improvement being estimated at $90,698.40.

Duck Creek was surveyed in 1878 under the direction of Col. J. N. Macomb, Corps of Engineers, and a project submitted for its improvement recommending a 6-foot low-water channel 40 feet in width within the creek, and a channel 100 feet wide and 8 feet deep at the entrance. It appears that the improvement of the mouth was subsequently held to be of greater importance than that of the creek on account, as then stated, of the evident desirability of harbors of refuge for the numerous small vessels engaged in fishing, oystering, and freighting that navigate the broad reaches of Delaware Bay, for which Duck Creek entrance offers superior natural advantages. Between the years 1880 and 1882 appropriations aggregating $10,000 were expended by special direction of Congress in dredging the bar at the mouth. A channel nearly 100 feet wide and 8 feet deep at low water was made, but shortly filled up again to such an unexpected extent that no further appropriation for dredging at that point was recommended by the officer in charge unless protective works were first provided for.

Before the recent improvements were commenced the steamers plying upon this stream could not ascend higher than Rothwell's Landing, about 3 miles below Smyrna. They are now enabled to reach Smyrna Landing at all stages of the tide, and are thus brought within a mile of the town, the result being a reduction in the hauling time of freight and in freight rates. In reference to the latter, it is stated that material used in the manufacture of phosphates which formerly could be received by rail only, is now shipped entirely by water from New York City and Philadelphia at a rate reduced from $3.90 to $1.11 and from $2 to 50 cents per ton, respectively. The fertilizer factory has been much enlarged; limekilns have been constructed, and two canning houses are now in process of erection.

It is proposed to expend the amount asked for in continuing dredging within the creek in pursuance with the project carried on last year.

Duck Creek is in the collection district of Delaware; Wilmington is the nearest port of entry, and the revenue collected there during the fiscal year ending June 30, 1890, was $6,536.10.

AMOUNTS APPROPRIATED.

By act approved—	
June 14, 1880	$5,000
March 3, 1881	3,000
By act passed August 2, 1882	2,000
By act of August 11, 1888	10,000

Money statement.

July 1, 1889, amount available	$89.72
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	89.72
Amount appropriated by act of September 19, 1890	*5,000.00
Amount (estimated) required for completion of existing project	22,365.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	10.000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Receipts or imports.

Classification.	Weight.	Value.
	Tons.	
a. Raw products: Bone, cord-wood, phosphate, rock, coal, iron and ice	6,800	$82,000
b. Manufactured products: Canned goods, fertilizers, flour, lumber, sulphuric acid	9,096	219,200
c. Agricultural products: Butter, grain, hay, potatoes, cattle, horses, sheep, etc	23,671	295,000
d. General merchandise	20,000	400,000
Total	59,567	996,200

Shipments or exports.

Classification.	Weight.	Value.
	Tons.	
a. Raw products: Cord-wood, ship timber, and railroad ties	65,135	$190,000
b. Manufactured products: Baskets, bricks, canned goods, carriages, crates, fertilizers, and tile	119,138	915,000
c. Agricultural products: Berries, butter, cattle and horses, eggs, fruit, truck, grain, hay, potatoes, poultry, sheep and wool	20,493	839,400
Total	204,766	1,944,000

Total tonnage for the year 1889–'90, 264,333.
Total tonnage for the year 1888–'89, 248,944.
Increase since last report, tons, 15,389.

Vessels navigating Duck Creek, Delaware.

Class.	No.	Aggregate tonnage.	Draught.	Remarks.
			Feet.	
Steamers, passenger and freight	3	490	5½ to 6	Regular trips during fruit season and summer; irregular during the remainder of the year.
Tug-boats	4		6	
Schooners	5	500	5 to 7	
Sloops				Quite numerous; exact number could not be ascertained.

*This amount was appropriated by act of September 19, 1890, for improving Smyrna River, Delaware, continuing improvement.

H 5.

IMPROVEMENT OF ST. JONES RIVER, DELAWARE.

At the beginning of the past fiscal year a contract had been entered into to expend the appropriation of $15,000, made by the act of August 11, 1888, under the approved modified project.

This project provided for a cut across the bar at the mouth from the 6-foot depth inside the creek to the corresponding depth outside the bar, the width to be 100 feet, of which 50 feet in the center were to be dredged to a depth of 6 feet, the remainder to a depth of 3 feet below mean low water, the material to be deposited on each side of the cut to form training banks, and the outer ends of these banks to be strengthened with pile revetment. In addition, the project provided for a new cut-off at a bend in the river 2 miles below Lebanon. Work under this contract was commenced on August 1, and was completed December 31, 1889. The total amount of material removed by the contractor was 58,015 cubic yards, of which 40,333 cubic yards were dredged at the bar at the mouth and 10,275 cubic yards at the new cut-off made near Wharton's Fishery. The remainder, 7,407 cubic yards, were removed under written agreement with the contractor at the original contract price, 18 cents per cubic yard, from two shoals near the mouth and inside the river, at Lea's Landing and Broad Reach. During the progress of dredging operations at the bar the contractor erected at the outer ends of the banks thrown up along the cut the triangular-shaped revetment walls designed for their protection. Each wing is 40 feet long and the total length of revetments driven is 160 feet.

The work done during the fiscal year ending June 30, 1890, completes the improvement of St. Jones River as originally contemplated. At the close of operations there existed an unobstructed 6-foot low-water navigation between the Delaware Bay and Dover, Del., with a channel width of nearly 100 feet at the mouth over the bar and of 40 feet inside the river. The cut made across the bar does not yet show, according to the latest information received, any signs of shoaling. Although the banks thrown up along the sides were to some extent leveled down by the waves soon after they were made, as had been expected, their remaining elevation above the general level of the bottom is still such as to prevent a diffusion of the confined currents for the entire length of the cut, about 4,800 feet, and the currents, especially during the last stages of the ebb, are exceedingly strong and would warrant that no apprehension be felt for an early deterioration of this improvement.

The original project for the improvement of this river was made in 1880, and provided for a 3-foot channel 100 feet wide across the bar at the mouth, protected by a jetty, at an estimated cost of $35,000. The project was enlarged in 1884 to include the removal of the shoals in the river to a depth of 6 feet at mean low water. The first appropriation, $5,000, was made in 1881, but was not expended until 1885, together with an appropriation of $10,000 made in 1884, when the work of dredging inside the river was commenced. Another appropriation of $10,000, made in 1886, was expended in the same manner, in addition to which a small cut 4 feet deep and 40 feet wide was made across the bar at the mouth.

The original project for the improvement of the mouth was modified in 1889, after a thorough examination of the subject, dispensing with the jetty and substituting instead banks thrown up along the sides of the cut. This project was approved and carried out during the past

fiscal year, as above reported. The total amount expended at the close of the fiscal year ended June 30, 1890, is $39,509.84.

A regular steam-boat line was established between Dover, the numerous landings on the river and Philadelphia, shortly after improvements were begun. Until last year the trips were timed according to the occurrence of high water at the bar; since then, the steam-boat and in fact all vessels can enter and leave at any stage of the tide, which is an important item, especially in the transportation of perishable freight.

No further appropriation is recommended.

Dover is in the collection district of Delaware; Wilmington is the nearest port of entry, at which the amount of revenue collected during the last fiscal year is $6,536.10.

AMOUNTS APPROPRIATED.

By act approved—	
March 3, 1881	$5,000
July 5, 1884	10,000
August 5, 1886	10,000
By act of August 11, 1888	15,000

Money statement.

July 1, 1889, amount available	$2,688.16
July 1, 1889, amount covered by existing contract	11,900.00
	14,588.16
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	14,097.64
July 1, 1890, balance available	490.52

COMMERCIAL STATISTICS.

Receipts.

Classification.	Weight.	Value.
	Tons.	
Raw products: Coal, ice, pig tin and lead	2,620	$19,050
Manufactured products: Fertilizers, lumber, tin-plate, iron supplies	7,651	316,150
Agricultural products: Horse, hay, and tropical fruit	414	59,210
General merchandise	9,065	469,085
Total	19,750	863,495

Shipments.

Classification.	Weight.	Value.
	Tons.	
Raw products: Cordwood, logs	897	32,975
Manufactured products: Barrels, baskets, canned goods, and fertilizers	2,611	142,250
Agricultural products: Berries, fruit, grain, potatoes, and cattle	16,816	378,465
Total	20,324	523,700

Total for the year 1889–'90	tons	40,074
Total for the year 1888–'89	do	25,250
Increase since last report	do	14,824

Vessels navigating St. Jones River.

Class of vessels.	No.	Total registered tonnage.	Draught.	Trips.
			Feet.	
Steamers	1	125	5½	Tri-weekly.
Schooners	5	325	3½ to 7	Weekly.

H 6.

IMPROVEMENT OF MISPILLION CREEK, DELAWARE.

There were no operations during the fiscal year ending June 30, 1890.

An appropriation of $3,500 made by the river and harbor act of August 11, 1888, was expended during the following winter in dredging several shoals within the stream.

The improvement of this creek was commenced in 1879 The approved project is for a 6-foot low-water channel 40 feet wide from Milford, the head of navigation, to the mouth. A project was submitted February 20, 1882, by Capt. William Ludlow, Corps of Engineers, for the improvement of the mouth of the creek, comprising a channel either 3 or 4 feet in depth across the bar and protected on the north side by a jetty, at an estimated cost of $49,000 or $55,000 respectively.

Work under the improved project for the improvement of the creek between the mouth and Milford has been carried on with appropriations made at various times as tabulated below. Up to the close of the past fiscal year the sum of $17,000 has been expended. The result is a clear channel not less than 6 feet deep at mean low water and 40 feet wide from Milford to Flat Reach Shoal near the mouth, a distance of 12 miles. This shoal remains to be dredged, and it is estimated that the present project can be completed for $2,000.

Mispillion Creek is in the collection district of Delaware; Wilmington is the nearest port of entry, at which the amount of revenue collected during the fiscal year ending June 30, 1890, was $6,536.10.

AMOUNTS APPROPRIATED.

By act approved—	
March 3, 1879	$3,000
June 14, 1880	4,000
March 3, 1881	3,500
By act passed August 2, 1882	3,000
By act of August 11, 1888	3,500
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	$2,000

COMMERCIAL STATISTICS.

Receipts.

Classification.	Weight.	Value.
	Tons.	
Raw products: Bone, coal, iron, phosphate rock, marble	10,180	$159,000
Manufactured products: Chemicals, fertilizers, flour, sawed lumber, lime	7,459	76,750
Agricultral product: Hay	100	2,000
General merchandise	2,000	40,000
Total	19,739	277,750

Shipments.

Classification.	Weight.	Value.
	Tons.	
Raw products: Cord-wood, logs, railroad ties, ship-timber	19,252	$468,000
Manufactured products: Baskets, crates, canned goods, fertilizers	3,083	170,000
Agricultural products: Corn and wheat	2,041	44,500
General merchandise	200	6,000
Total	24,576	688,500

Total tonnage last report	tons	51,481
Total tonnage present report	do	44,315
Decrease since last report	do	7,166

Vessels navigating Mispillion Creek, Delaware, during the year 1889–'90.

	No.	Aggregate tonnage.	Draught.	Trips.
			Feet.	
Freight steamers	1	65	5½	Fifteen per year.
Tug-boats	3	57	4–5½	Daily.
Schooners	22	1,152	4–6½	Four to thirty per year.

Vessels built and repaired at Milford, Del., during the year 1889–'90.

	No.	Registered total tonnage.	Draught of largest vessel when leaving shipyard.	Calculated maximum draught (when loaded) of largest vessel built.
			Feet.	*Feet.*
Built:				
Tug-boats	2	150	7½	12
Schooners	2	750	7	.....
Repaired:				
Steamers	2	Not given.	.....	.....
Sailing vessels	6	300	.....	.....

H 7.

IMPROVEMENT OF BROADKILN RIVER, DELAWARE.

The appropriation of $10,000 made by the act of August 11, 1888, was still unexpended at the close of the fiscal year ending June 30, 1889, having been withheld on account of prevailing high prices for dredging. The conditions having taken a more favorable turn during the past fiscal year, the work was advertised in November, and bids opened on December 28, 1889. The American Dredging Company, of Philadelphia, were the lowest bidders, and contract was entered into with them under date of January 30, 1890, at their bid of 7 cents per cubic yard, measured in place.

Dredging was commenced on May 28, 1890, and up to the close of the fiscal year 20,972 cubic yards of material had been removed from the channel.

The available funds are to be expended mainly between Green Island and the mouth of the river, where no dredging has heretofore been done. Certain portions of the channel in the upper river will be widened. At the close of the fiscal year 4,690 feet of the proposed channel below Green Island had been completed.

The original project was made in 1871, and is for a 6-foot low-water navigation from the mouth to Milton, Del., the head of navigation, and for a new entrance protected by a jetty, at an estimated cost of $80,447. The project was modified in 1881 as to the latter portion of it, and the estimate reduced to $51,450.

Dredging has been done at various times in the river since 1873 for a channel 6 feet deep and 40 feet wide at mean low water. Up to the close of the fiscal year ending June 30, 1890, the sum of $26,123.19 had been expended.

With the exception of a few places where banks have caved in and slightly reduced the width of the channel, there is now a clear 6-foot channel 40 feet wide from a point 3,300 feet below Green Island to Milton, and the expenditure of the present appropriation will complete that portion of the project relating to the dredging of the channel inside the river.

This work is in the collection district of Delaware; Wilmington is the nearest port of entry, at which the amount of revenue collected during the fiscal year ending June 30, 1890, was $6,536.10.

AMOUNTS APPROPRIATED.

By act approved—	
March 3, 1873	$10,000
June 14, 1880	5,000
March 3, 1881	5,000
By act passed August 2, 1882	5,000
By act of August 11, 1888	10,000

Money statement.

July 1, 1889, amount available		$9,591.21
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$714.40	
July 1, 1890, outstanding liabilities	1,297.87	
July 1, 1890, amount covered by uncompleted contracts made during fiscal year ending June 30, 1890	6,531.96	
		8,544.23
July 1, 1890, balance available		1,046.98
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		21,500.00

Abstract of proposals opened by General Wm. F. Smith, United States Agent, December 28, 1889, for dredging in Broadkiln River, Delaware.

No.	Name and address.	Time.		Price per cubic yard, place measurement.
		Commence.	Complete.	
			1890.	Cents.
1	Atlas Dredging Company, Wilmington, Del.	At once	June 30	12
2	American Dredging Company, Philadelphia, Pa.	May 1, 1890	Aug. 1	7
3	National Dredging Company, Wilmington, Del.	Within 30 days	July 1	23

Contract with American Dredging Company.

COMMERCIAL STATISTICS.

Commercial statistics were not furnished in sufficient detail upon the blanks sent to parties interested. The total value of shipments and receipts for 1889–'90 was stated to be $372,000, or, if reduced to weight, approximately, 48,550 tons. From 1887 until the present report the aggregate amount of the commerce on the river for each year was stated to have remained the same, viz, $534,000; the statement furnished this year would therefore show a decrease, which is partly attributed to the failure of crops.

The aggregate tonnage of vessels owned by parties living on the stream is said to be 1,200; that of transient vessels, 700.

H 8.

IMPROVEMENT OF INLAND WATER-WAY FROM CHINCOTEAGUE BAY, VIRGINIA, TO DELAWARE BAY AT OR NEAR LEWES, DELAWARE.

Work was continued on the cut between Assawoman Bay and Indian River Bay during the past fiscal year under the contract with Mr. C. McLean, of New York. The time for the completion of the contract having expired on August 1, 1889, it was extended to December 1, 1889. The progress of the work having been much delayed by strikes of laborers and by the refusal of the owners of adjoining property to sell the necessary land for dumping-grounds except at exorbitant prices, it became necessary to grant the contractor a second extension until April 1, 1890, and a third one until August 1, 1890.

During the past fiscal year 46,838 cubic yards of material have been excavated, which, with the amount previously removed, makes a total of 93,457 cubic yards since the work was commenced. The total amount of material to be removed is estimated at 201,000 cubic yards. The contractor has been compelled to construct upon the ground special machinery and excavating plant, and progress has been slow. He, however, promises to put on new machines, which he says will push the work forward rapidly. It is not probable, however, that the work will be done at the specified date.

The approved project for the expenditure of the appropriations of August 5, 1886, and August 11, 1888, of $18,750 and $50,000 respectively is for a cut 20 feet wide at the base and 2 feet deep below the mean water level of Assawoman Bay, connecting this bay with Indian River Bay, a distance of nearly 4 miles. By a supplementary agreement entered into with the contractor in July, 1889, and approved by the Chief of Engineers, the depth of the proposed cut was increased to 4 feet below the mean level of Assawoman Bay.

Anticipating the time when the excavation now in progress would reach several public-road crossings along the line of the cut, and to prevent an interruption of travel at these points, the Government having previously agreed to maintain all public-road crossings, arrangements were made during the past winter for the erection of temporary bridges. These were found necessary at three places: at Cedar Neck road, at Beach road, and at Jefferson Creek road. The plans, for plain truss bridges having a general width of 16 feet, one to be 75 feet, the others 55 feet long, were approved, and proposals for their construction were invited by advertisement.

Four bids were received, and a contract was made on March 24, 1890,

with the lowest bidder, at the aggregate price of $1,193 for the three bridges. The contractor has prepared the framing for each bridge. The erection of the structures is, however, necessarily delayed until the excavation of the cut has been made to the full depth at and near the crossings mentioned.

The approved project is based upon a survey made in 1884 to examine the physical condition of the bays and country traversed, with the view of forming an inland navigation from Chincoteague Bay, Virginia, to Delaware Bay at or near Lewes, Del. The project proposes a channel to be made, by dredging or otherwise, 70 feet wide at the bottom and 6 feet deep below the mean low-water, level as established by the Engineer Department, up in the harbor formed by the Delaware Breakwater. The total estimated cost is $350,000. By direction of Congress the two appropriations made to date were to be expended between Chincoteague and Indian River bays, and the funds are now being applied, as above stated, to the construction of a channel connecting the waters of Assawoman and Indian River bays.

The state of the work at the close of the fiscal year ending June 30, 1890, is as follows:

Of the total of 201,000 cubic yards to be excavated 110,828 have been removed. The southern end of the cut is completed to the specified depth and width, 4 and 20 feet respectively, for a continuous distance of 6,400 feet.

The remaining section of the cut is irregular in depth and width, with short portions at a few points which are excavated to the required dimensions.

During the past fiscal year observations of the water-levels have been made in connection with the direction and force of the wind at Miller's Creek, the head of Assawoman Bay, with a self-registering gauge and anemometer, and at White's Creek, a branch of Indian River Bay, by staff readings, and for the last two months with a self-registering gauge.

These observations are of value to determine the effects the winds will produce upon the surface of the bays, and inferentially the resulting currents, when the two bays are connected. They will be continued and the results reported in due time, together with similar observations and studies yet to be made on other sections of the proposed canal.

It is impossible to estimate the amount of commerce that will be created by the improvement. As yet none is to be reported.

It is proposed to expend the appropriation asked for at those points of the proposed route where the heaviest and most important work is to be done, so that the whole channel may be utilized to a certain extent before it is entirely finished, and may be gradually completed to its final depth and width. In addition to the amount reported excavated during the past fiscal year, 17,371 cubic yards were removed, but are not to be paid for, under the terms of the supplementary contract, until the contractor has completed the channel throughout to a depth of 4 feet and 20 feet wide at the bottom from the 4-foot depth in Assawoman Bay to the 4-foot depth in Indian River Bay.

AMOUNTS APPPROPRIATED.

By act approved August 5, 1886	$18,750
By act of August 11, 1888	50,000

Money statement.

July 1, 1889, amount available		$22,270.62
July 1, 1889, amount covered by existing contract		31,823.78
		54,094.40
July 1, 1880, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$10,632.53	
July 1, 1890, outstanding liabilities	3,804.82	
July 1, 1890, amount covered by existing and uncompleted contracts made during the fiscal year ending June 30, 1890	24,602.36	
		39,039.71
July 1, 1890, balance available		15,054.69
Amount appropriated by act of September 19, 1890		50,000.00
Amount available for fiscal year ending June 30, 1891		65,054.69
Amount (estimated) required for completion of existing project		231,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1892		100,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals received and opened March 6, 1890, by General William F. Smith, United States Agent, for constructing three wooden bridges across the cut from Chincoteague Bay, Virginia, to Indian River Bay, Delaware.

No.	Name and address.	Price.			Time.		Aggregate of bids.
		Cedar Neck road bridge.	Beach road bridge.	Jefferson Creek road bridge.	Commence.	Complete.	
1	W. J. McNatt, Georgetown, Del.	*$685 † 695	*$616 † 626	*$772 † 782	Not given	Not given	$2,073 2,103
2	George H. West, Ocean View, Del., and George H. Townsend, Millville, Del.	‡ 675	‡ 575	‡ 625	....do	Within 30, 60, and 90 days from date of contract in order named	1,875
3	William H. Virden, Lewes, Del.	§ 335	§ 365	§ 493	....do	Not given	1,193
4	Colin McLean, New York, N. Y	‖ 550	‖ 434	‖ 500	....do	....do	1,484 1,784

* With pile foundation.
† With trestle foundation.
‡ Either pile or trestle foundation.
§ According to plans and specifications.
‖ If piles are used, $25 per pile.

Contract with William H. Virden.

H 9.

IMPROVEMENT OF BROAD CREEK, DELAWARE.

At the close of the fiscal year ending June 30, 1889, a contract had been made to expend in dredging the appropriation of $5,000 made August 11, 1888, and it was expected that work would begin some time during the following fall. The money was to be used in dredging a channel 50 feet wide and 6 feet deep at mean low water from the Delaware railroad bridge to the turning-basin at Laurel, Del.

Operations were commenced on October 2, 1889. While the work was going on it was discovered that considerable mud and sand had been washed into the creek from above during the heavy freshet of June 1, 1889, and had formed a shoal with less than 6 feet of water over it for a distance of 600 feet below the bridge. There existed also several sharp projections of the banks of the stream at certain bends about 2 miles below Laurel, which made navigation difficult at those points. The citizens of Laurel asked, by petitions, for the removal of the shoal and projecting points, and authority was obtained from the Chief of Engineers to expend any available balance after the completion of the contract then in force for the amelioration of these obstructions.

A written agreement was made with the contractor to do the additional dredging under the same terms and conditions as his contract work, viz: at the rate of 20 cents per cubic yard of material removed and measured in place. The contract was completed on November 9, 1889, a total 19,987 cubic yards of material having been removed of which amount 5,723 cubic yards were removed under written agreement. The result of the year's work was the extension of the approved channel from the railroad bridge up to the head of navigation, the turning-basin at Laurel.

This completes the originally-adopted project for the improvement of Broad Creek, which required the dredging of a 6-foot low-water channel 50 feet in width from a point about 3 miles below Laurel, Del., to the turning-basin in the town.

The creek has been under improvement since 1881, and at the close of the fiscal year ending June 30, 1890, the sum of $35,000 had been expended.

Broad Creek is in the collection district of Delaware; Wilmington is the nearest port of entry, at which the amount of revenue collected for the fiscal year ending June 30, 1890, is $6,536.10.

AMOUNTS APPROPRIATED.

By act approved—	
June 14, 1880	$5,000
March 3, 1881	10,000
By act passed August 2, 1882	5,000
By act approved August 5, 1886	10,000
By act of August 11, 1888	5,000

Money statement.

July 1, 1889, amount available	$728.25
July 1, 1889, amount covered by existing contract	4,250.00
	4,978.25
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	4,978.25

COMMERCIAL STATISTICS.

Receipts.

Classification.	Weight.	Value.
	Tons.	
Raw products: Coal, iron, ship-timber, salt, ice	7,970	$243,650
Manufactured products: Building material, fertilizers, etc	1,590	15,695
Agricultural products: Grain, etc	860	17,700
General merchandise	8,000	320,000
Total	18,420	597,045

Shipments.

Classification.	Weight.	Value.
	Tons.	
Raw products: Cord-wood	4,620	$11,550
Manufactured products: Baskets, crates, lumber, and flour	2,676	85,250
Agricultural products: Berries, fruit, and garden truck	3,000	112,685
General merchandise	6,000	120,000
Total	16,296	329,485

Total receipts and shipments, 34,716 tons, which, it is stated, is an increase of about 25 per cent. since the improvement of the creek was commenced.

Vessels navigating Broad Creek, Delaware, during the year 1889–'90.

Class of vessels.	No.	Aggregate tonnage.	Draught.	Trips.
			Feet.	
Steamers	1	40	5	Daily.
Schooners	5	650	6½ to 8	About once a month.

Vessels built and repaired at Bethel, Delaware, during the year 1889–'90.

	No.	Registered, total tonnage.	Draught of largest vessel when leaving shipyard.	Calculated maximum draught, when loaded, of largest vessel built.
			Feet.	*Feet.*
Built, schooners	2	700	5	8
Repaired, sailing vessels	50	6,250	.....	.....

H 10.

IMPROVEMENT OF SUSQUEHANNA RIVER, ABOVE AND BELOW HAVRE DE GRACE, MARYLAND.

At the close of the fiscal year ending June 30, 1889, a contract had been entered into to expend the appropriation of $10,000, made by the act of August 11, 1888, in dredging. The project was for continuing the removal of the shoal located along the western shore of the river, opposite Watson's Island. Operations were begun on July 8, 1889,

and continued until August 17 following, during which time 47,978 cubic yards of material were removed. This material consisted mainly of fine river-sand and drift, deposited there by recent freshets. The expenditure of the money resulted in increasing the width of the 8-foot channel at the point named 200 feet.

The removal of the eastern bank of this shoal to a depth of 8 feet below mean low water has been in progress since 1883. The object of the improvement is to prevent, to a certain degree, the formation of ice-gorges at and near Port Deposit, Md., a town situated about 2¼ miles above Watson's Island. At the close of the fiscal year ending June 30, 1890, about $32,000 had been expended since the removal commenced. The result has been a considerable increase in the original width of the channel, and it is stated that this has already had the effect to relieve the ice-gorges.

The original project for the improvement of this river above and below Havre de Grace includes the making of a 15-foot low-water channel below the city and the removal of the shoal opposite Watson's Island to a depth of 8 feet below mean low water. The channel below the city was dredged to a depth of 12 feet in 1885; its present condition shows that it has partially shoaled again.

On October 28, 1889, the Chief of Engineers directed that a careful survey of the river below Port Deposit be made. This survey was made in November and a copy of the map was forwarded in December following.

The amount asked for for the fiscal year ending June 30, 1892, is the amount estimated as necessary for annual dredging.

Susquehanna River is in the collection district of Baltimore, which is also the nearest port of entry. The amount of revenue collected there during the fiscal year ending June 30, 1890, is $2,951,827.83.

AMOUNTS APPROPRIATED.

By act approved—	
August 30, 1852	$10,000
June 23, 1866	26,400
July 11, 1870	12,000
June 14, 1880	28,000
March 3, 1881	15,000
By act passed August 2, 1882	25,000
By act approved—	
July 5, 1884	20,000
August 5, 1889	6,000
By act of August 11, 1888	10,000

Money statement.

July 1, 1889, amount available	$1,478.65
July 1, 1889, amount covered by existing contract	8,500.00
	9,978.65
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	9,606.40
July 1, 1890, balance available	372.25
Amount appropriated by act of September 19, 1890	4,000.00
Amount available for fiscal year ending June 30, 1891	4,372.25

Amount (estimated) required for annual dredging	20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	20,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1886 and 1887.

COMMERCIAL STATISTICS.

Articles.	Tons.	Value.
Coal	146,832	$503,923
Lumber, shingles, and timber	20,766	216,800
Stone, sand, and ground flint	18,449	25,514
Fertilizers	200	4,000
Hay and grain	580	12,214
Spruce wood	2,000	8,000
Tide-water canal freight	57,500	187,500
	246,317	968,756

H 11.

IMPROVEMENT OF FAIRLEE CREEK, MARYLAND.

There was no work done in this creek during the past fiscal year. An appropriation of $5,000, made by the act of August 11, 1888, was the first one made for this improvement, and was exhausted during the fiscal year ending June 30, 1889, in dredging a channel across the bar at the mouth 7 feet deep and about 80 feet wide.

The project adopted in 1887 embraces the dredging of a channel 100 feet wide and 7 feet deep at low water across the bar at the mouth and within the creek as far as the present navigation extends, a distance of nearly 2¾ miles, and the excavation of a turning basin at the upper end of the proposed channel, if a wharf should be built there before the channel is finished. The total estimated cost of the improvement is $15,558.

The channel at the bar is not likely to remain open unless protective works are built, and it is possible that the cut already made may have filled in considerably or may be entirely closed again before operations are resumed.

It is proposed to expend the amount asked for, if appropriated, in continuing the improvement of the channel at the mouth of the creek.

Fairlee Creek is in the collection district of Baltimore, which is the nearest port of entry. The amount of revenue collected there during the fiscal year ending June 30, 1890, was $2,951,827.83.

AMOUNT APPROPRIATED.

By act of August 11, 1888 ..... $5,000

Money statement.

July 1, 1889, amount available	$309.31
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	309.31
Amount appropriated by act of September 19, 1890	5,000.00
Amount (estimated) required for completion of existing project	5,558.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	5,558.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Receipts.

Classification.	Weight.	Value.
	Tons.	
Raw products: Bone, coal, and phosphate	145	$1,725
Manufactured products: Bricks, fertilizers, flour, lumber, and shingles	397	4,338
Agricultural products: Butter, etc	1	150
General merchandise	500	10,000
Total	1,043	16,213

Shipments.

Classification.	Weight.	Value.
	Tons.	
Raw products: Cord-wood and sand	115	$150
Manufactured products: Iron supplies	5	175
Agricultural products: Grain, hay, potatoes, and poultry	2,466	51,370
Total	2,586	51,695

Total transportation by water, 3,629 tons.

There is one schooner of 26 tons burden and drawing 4 feet of water trading in and out of Fairlee Creek.

LETTER OF JUDGE W. S. WALKER.

WHITE HOUSE, NEAR CHESTERTOWN, MD., *June* 20, 1890.

DEAR SIR: I really feel ashamed to forward you the meager and, in my judgment, the inadequate estimates of the business of Fairlee Creek, especially after having had the blanks so long. Did the time and opportunity now permit, I would myself make a canvass and furnish more reliable data. I left this matter in the hands of a merchant in the village of Fairlee and requested him to call to his aid the farmers and others assembling at his place of business and post-office, but he seems only to have called on the captain of a sailing vessel.

There has been no increase in the tonnage of the creek for the reason that the peach crop has been a failure. Parties in Baltimore wanted to put a steamer in Fairlee Creek, but I discouraged them and told them they had better wait another year. In ordinary season I feel sure the imports and exports of Fairlee Creek would be four times the amount set down, and I feel confident the estimates forwarded do not begin to represent the business of the creek. * * *

Yours, truly,

W. S. WALKER.

General WM. F. SMITH.

H 12.

IMPROVEMENT OF CORSICA CREEK, MARYLAND.

This improvement was reported completed in the annual report for the fiscal year ending June 30, 1889.

As no tabulated commercial statistics were furnished during the past three years and none could this year be obtained, it is impossible to give a comparative statement of the extent to which the commerce of the creek has been benefited by its improvement.

Corsica Creek is in the collection district of Baltimore, which is also the nearest port of entry, and the amount of internal revenue collected there during the fiscal year ending June 30, 1890, is $2,951,827.83.

AMOUNTS APPROPRIATED.

By act passed August 2, 1882	$5,000
By act approved July 5, 1884	5,000
By act approved August 5, 1886	10,000
By act of August 11, 1888	10,000

Money statement.

July 1, 1889, amount available	$594.41
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	594.41

H 13.

IMPROVEMENT OF CHOPTANK RIVER, MARYLAND.

At the close of the fiscal year ending June 30, 1889, the appropriation of $7,500 made August 11, 1888, was still withheld on account of prevailing high prices for dredging. Authority to have the work done in open market was obtained from the Chief of Engineers, and an agreement was made with the American Dredging Company, of Philadelphia, for dredging at 15 cents per cubic yard, measured in place. The work had been advertised twice before, in October, 1888, and February, 1889, and the lowest bid received in each case was 28 cents per cubic yard.

Dredging operations were commenced on June 25. 1890, and are now in progress. The available funds will be expended in dredging a channel 40 feet wide and 8 feet deep from the point where operations were suspended in 1888, at Case's Wharf, up towards the head of navigation, and in removing several shoals further down the river.

At the close of the last fiscal year 1,972 cubic yards of material had been removed, and the channel had been extended 222 feet. It is expected that the work now in progress will be completed about the middle of August, 1890.

The object of this improvement, which has been carried on since 1881, is to give an 8-foot low-water navigation from deep water in the river below to the bridge at Greensborough, Md., by dredging a channel 75 feet in width. Up to the close of the fiscal year ending June 30, 1889, $30,076.26 had been expended. The total length of the river under improvement is about 8 miles. At the time just named there remained to be dredged to a depth of 8 feet about 3 miles of the total distance, having a minimum depth of water at low tide of from 5 to 7 feet.

At several points the channel dredged is still too narrow and needs widening, especially at the sharp turns in the river.

The improvement has been of great benefit to the country around the town of Greensborough, and below. For the past three years a steam-barge has been making regular trips between this town and Baltimore, and is very rarely detained by low tides. Two large schooners and a number of smaller sailing-vessels trade regularly in the river. It is stated that as soon as the channel, now being made, is extended nearer the old wharves at Greensborough, another steam-boat line will be established for the transportation of freight and passengers to and from Baltimore. It is proposed to expend the amount asked for, if appropriated, in dredging the channel at Greensborough to the full proposed width and depth and thereafter to continue the removal of the shoal portions of the river below.

Choptank River is in the collection district of Baltimore, which is also the nearest port of entry. The amount of revenue collected there during the fiscal year ending June 30, 1890, was $2,951,827.83.

AMOUNTS APPROPRIATED.

By act approved—	
June 14, 1880	$5,000
March 3, 1881	5,000
By act passed August 2, 1882	5,000
By act approved—	
July 5, 1884	5,000
August 5, 1886	10,000
By act of August 11, 1888	7,500

Money statement.

July 1, 1889, amount available		$7,423.74
July 1, 1890, amount exended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$61.36	
July 1, 1890, outstanding liabilities	295.50	
		356.86
July 1, 1890, balance available		7,066.88
Amount appropriated by act of September 19, 1890		7,500.00
Amount available for fiscal year ending June 30, 1891		14,566.88
Amount (estimated) required for completion of existing project		23,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892		10,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Receipts.

Classification.	Weight.	Value.
	Tons.	
Raw products: Coal, ice, and oyster shells	1,185	$2,958
Manufactured products: Fertilizers, furniture, sawed lumber, tin cans, etc	2,037	47,524
Agricultural products: Hay	20	360
General merchandise	1,200	48,000
Total	4,442	98,842

Shipments.

Classification.	Weight.	Value.
	Tons.	
Manufactured products: Canned goods	100	$7,500
Agricultural products: Grain	1,979	52,059
General merchandise	386	5,790
Total	2,465	65,349

Total shipments and receipts by water, 6,907 tons. No accurate statistics with reference to transportation by water having been furnished before, no comparison can be made with former years.

H 14.

IMPROVEMENT OF HARBOR AT CAMBRIDGE, MARYLAND.

There were no operations during the fiscal year ending June 30, 1890.

The appropriation of $5,000 made August 11, 1888, was expended during the fiscal year ended June 30, 1889, in dredging a channe 188 feet wide and 12-feet deep from the 12-foot curve in the Choptank River across the bar at the entrance to a point just opposite the Maryland Steam-boat Company's wharf, and a single cut of the same depth and 22 feet wide from this point to the railroad wharf inside the harbor.

The approved project is based upon a survey made in 1887. It provides for a channel 150 feet wide and 12 feet deep at mean low water from the Choptank River to the railroad wharf, for dredging a certain irregular area within the harbor to a depth of 10 feet at mean low water and for a channel 150 feet wide and 8 feet deep at the same stage of the tide from the draw-bridge above the railroad wharf to the upper limits of the harbor.

This harbor has been under improvement by the General Government since 1871. Previous to that year the citizens of Cambridge had expended $7,500 in its improvement. A project was submitted in 1871, by Col. William P. Craighill, Corps of Engineers, and approved which provided for a channel 150 feet wide across the bar at the entrance and for dredging the same and the interior of the harbor to a depth of 8 feet at mean low tide. This project was completed in 1879, but, the channel at the entrance needing enlargement soon thereafter, the appropriation of $2,500 made the same year was expended in 1884 in increasing the width as far as the funds would permit. At the end of that year the total amount expended was $32,500.

The amount expended under the present project is $4,900.

The result of the improvement has been that schooners of about 150 tons displacement, engaged in carrying ice and ship timber, which heretofore have been compelled to anchor outside the bar for lack of depth in the channel and to discharge and load their cargoes by means of lighters, have been enabled the past year to sail directly up to the railroad wharf inside the harbor. Shipping expenses have decreased in consequence and the demand for the larger class of vessels is on the increase.

It is proposed to expend the amount asked for, if appropriated in continuing the improvement in accordance with the present project.

Cambridge Harbor is in the collection district of Baltimore, which is the nearest port of entry. The amount of revenue collected there during the fiscal year ending June 30, 1890, is $2,951,827.83.

AMOUNTS APPROPRIATED.

By act approved:	
March 3, 1871	$10,000.00
June 10, 1872	10,000.00
March 3, 1873	5,000.00
June 18, 1878	5,000.00
March 3, 1879	2,500.00
By act of August 11, 1888	5,000.00

Money statement.

July 1, 1889, amount available	$171.09
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	71.09
July 1, 1890, balance available	100.00
Amount appropriated by act of September 19, 1890	5,000.00
Amount available for fiscal year ending June 30, 1891	5,100.00
Amount (estimated) required for completion of existing project	7,736.60
Amount that can be profitably expended in fiscal year ending June 30, 1892	7,736.60

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Receipts or imports.

Classification.	Weight.	Value.
	Tons.	
Raw products: Bone, coal, phosphate rock, ice, wood, oysters, ship timber, etc	29,341	$719,550
Manufactured products: Building material, flour, lumber, fertilizers, canned goods, etc	20,029	319,000
Agricultural products: Grain, live-stock, truck, poultry, eggs, butter, etc	31,278	1,766,842
General merchandise	10,950	547,500
Total	91,598	3,352,532

Shipments or exports.

Classification.	Weight.	Value.
	Tons.	
Raw products: Cord-wood, logs, railroad ties, ship-timber, oyster shells, etc	35,483	$518,850
Manufactured products: Barrels, fruit-crates, flour and meal, hominy, etc	32,366	1,213,898
Agricultural products: Berries, fruit, grain, live-stock, poultry, etc	24,848	872,705
General merchandise	14,600	438,000
Total	107,297	3,043,453

Total tonnage for the year 1889-'90	tons	198,895
Total tonnage for the year 1888-'89	do	111,160
Increase since last report	do	87,735

Vessels sailing from and to Cambridge Harbor during the year 1889-'90.

	No.	Aggregate tonnage.	Draught.	Trips.
			Feet.	
Freight and passenger steamers	4	2,220	7-9	Daily.
Schooners	12	790	7-10	Weekly and monthly.
Sloops	107	935	4½-6½	Daily during oyster season.

Vessels built and repaired at Cambridge, Maryland, during the year 1889–'90.

	No.	Registered total tonnage.	Draught of largest vessel when leaving ship-yard.	Calculated maximum draught, when loaded, of largest vessel built.
			Feet.	*Feet.*
Built:				
Schooners	10	700	10	12
Sloops	40	360	6	8
Repaired:				
Sailing-vessels	109	2,180	.....	.....

H 15.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

At the beginning of the fiscal year proposals for the removal of the wrecks of the pungy *Eva Hemingway*, sunk in Choptank River, and schooner *Two Brothers*, sunk in Cambridge Harbor, Maryland, had been invited by advertisement.

Bids were opened July 18, 1890, and the contract was awarded to George T. Johnson, of Cambridge, Md., for the sum of $689 for removal of both wrecks, and the work was completed in the following month.

In August 1889, the general agent of the Eastern Shore Steam-boat Company of Baltimore reported two dangerous obstructions in Chesapeake Bay in the track of their steamers. One was the wreck of the schooner *Jesse W. Knight*, sunk about three-fourths of a mile southwest of Sharp's Island Light-house, and the other was said to be the boiler of the steamer *Express*, which had foundered some twelve years before, and was said to be lying in the bay about half way between Hooper's and Kedge's Straits.

After due notice to owners and advertisement, proposals were opened on December 10, 1889, and a contract was entered into December 20, 1889, for their removal, with Mr. W. H. French, of Norfolk, Va., the only bidder, for the lump sum of $1,040.

The wreck of the schooner was removed on the 31st of the same month. The contractor subsequently made two diligent and careful searches for the boiler of the steamer, but was unable to find it, and it may have been moved by the currents into deep water, but this is not known.

Abstract of proposals opened by General William F. Smith, United States Agent, July 18, 1889, *for removal of wrecks of pungy Eva Hemingway and schooner Two Brothers from Choptank River and Cambridge Harbor, Maryland.*

No.	Name and address of bidder.	Price.
1	Ransom Bramble, Cambridge, Md	Both wrecks, $870.
2	George T. Johnson, Cambridge, Md	Both wrecks, $689.
3	Chester T. Caler, Norfolk, Va	First wreck, $489. Second wreck, $529.

Contract with George T. Johnson.

Abstract of proposals opened by General William F. Smith, United States Agent, December 10, 1889, for removal of wreck of schooner Jesse W. Knight and boiler of wrecked steamer Express from Chesapeake Bay.

No.	Name and address of bidder.	Price for removal of both obstructions.
1	W. H. French, Norfolk, Va	$1,040

Contract with W. H. French, dated December 20, 1889.

H 16.

PRELIMINARY EXAMINATION OF APPOQUINIMINK CREEK, DELAWARE.

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., October 18, 1888.

GENERAL: In compliance with the requirements of section 14 of the river and harbor act of August 11, 1888, and the instructions from the office of the Chief of Engineers of September 29, 1888, I have the honor to submit the following report upon the preliminary examination of Appoquinimink Creek, Delaware, made under my direction by Mr. A. Stierle, assistant engineer.

Appoquinimink Creek is situated in New Castle County, Del., and is a tributary of Delaware Bay. From its junction with the bay to the town of Odessa, the head of navigation, the distance is about 9 miles by water, the channel crooked, with low marshy banks, and having a width of from 100 to 200 feet. There is a depth of water at Odessa of about 4 feet at mean low tide, and at the bar at the mouth the depth at same stage is about 3 feet.

The tide rises at Odessa about 4 feet, and at the mouth about 6 feet. The improvement would contemplate the removal of shoals and increasing the width of the channel at certain sharp bends.

The adjacent country is highly cultivated, and the improvement would be a material benefit in the reduction of freights.

The stream is, in my opinion, worthy of improvement, and I recommend a survey of it. The least amount required to make the survey, with report and estimated cost of improvement, is $600.

Further details are contained in the report of the assistant engineer who made the examination, a copy of which is herewith inclosed.

Very respectfully, your obedient servant,

WM. F. SMITH,
United States Agent.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR A. STIERLE, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., October 15, 1888.

SIR: In compliance with your instructions of October 4, 1888, I have the honor to submit the following report on the preliminary examination of Appoquinimink Creek, Delaware:

This creek is situated in New Castle County, Del., and has its source on the dividing ridge of the peninsula formed by the State of Delaware and the eastern shores of Maryland and Virginia. In almost all of the streams of this peninsula the headwaters, which are the accumulations of rain-fall, are formed by large mill-ponds which collect the surface drainage of extensive areas, from which the united rivulets flow in a single stream through low and marshy lands to the bay. With the construction of these ponds the inflow of the tides, which had extended far into the interior, was cut off, and the ponds formed the head of navigation.

During the past four decades the commerce of these streams has suffered by the influence of railroad competition, and these highways were neglected and deteriorated. The constant increase in population and in the products of manufacture and cultivation demands a reopening and restoration of the former arteries of trade and commerce.

Appoquinimink Creek drains an area of about 50 square miles which is highly cultivated and rich in the products of the farm and factory. The Delaware Railroad crosses the creek near its source and the concomitant mill-pond, with the thriving towns of Middletown and Townsend as stations depending entirely upon the railroad for communication with other points. The town of Odessa, the present head of navigation, is situated about 5 miles below the mill-pond. There is no other place of importance on the banks of the creek.

From Odessa to its entrance into Delaware Bay the course of the creek is very tortuous and is about 9 miles in length. The width varies from 100 to 200 feet. The depth of water at mean low tide is about 4 feet at Odessa, increasing toward the mouth to an average of 6 feet. Several shoal places exist which have a depth of only 4½ to 5 feet over them at mean low water. The least depth of water over the bar at the mouth is 3 feet at the same stage of the tide.

The average rise and fall of the tide is about 4 feet at Odessa and nearly 6 feet at the mouth.

This voluminous tidal prism shows that the creek has inherent superior facilities for navigation and is susceptible of advantageous improvement at a minimum cost. The flow of the tide extends to about 4 miles above Odessa.

At this town a draw-bridge was built across the creek several years ago which has a clear span of only 20 feet. The effects of this sudden reduction of the cross-sectional area of the creek to about one-fifth of its normal one have already begun to show themselves. The creek above is rapidly filling up on account of the diminution of the tidal prism and the reaction upon the lower sections of the stream is correspondingly injurious, as the time of the flow of the ebb tide and its accompanying eroding qualities has been considerably reduced.

Vessels of large size sailed above this bridge before the present draw was constructed upon solid stone abutments, the former draw having had open pile piers and similar shore connections. At present only the smallest boats pass through. The facilities for wharfage above the bridge were originally as good as those below.

The interest in the improvement of the creek centers directly in the town of Odessa and its immediate vicinity. Two long and deep cuts, each about 35 feet wide, have already been made by private parties to shorten the route to the mouth. It appears to be the general desire to obtain a free and unobstructed 6-foot low-water navigation from the mouth to Odessa. Several parties, however, strongly advocate in addition the cutting off of at least four of the bends by dredging straight cuts across their base and the removal of projecting points at sharp turns of the creek. A draw-bridge is built at one of the bends, the piers of which are set obliquely with the currents; the difficulty of navigation through the draw is considerably increased by the adjacent sharp turns of the bend above and below.

No improvements by means of jetties or by dredging are desired at the mouth of the stream. In view of the pending improvements of the Delaware River and Bay, which include the construction of an extensive training dike parallel with the shore for the improvement of Dan Baker Shoal, just opposite the entrance to Appoquinimink Creek, it would be unwise to consider any project for the improvement of the mouth of the creek at present, as the physical conditions of the bay at that point are likely to be radically changed.

I consider the creek as well worthy of improvement and estimate the cost of a survey at $600.

The following is a summary of the commerce of the creek for the past year.

Exports.—400,000 bushels of grain, 200,000 baskets peaches and apples, 20,000 tons fertilizer, 5,000 tons sulphuric acid, 6,000 head live stock, 1,500,000 to 2,000,000 cans of canned fruit and vegetables, small fruit, and vegetables in large quantities.

Imports.—2,000,000 feet lumber, 500,0000 to 700,000 bricks, 100,000 bushels lime, 5,000 tons coal; general merchandise for about 5,000 people.

Lumber and kind of vessels passing in and out of the creek annually: 200 to 250 barges, capacity 200 to 250 tons; 250 to 300 tug-boats, 300 to 400 steamers, 150 to 200 schooners. The passenger traffic amounts to about 10,000 persons annually.

The above data were kindly furnished me by the Lord and Polk Chemical Company at Odessa.

Very respectfully, your obedient servant,

A. STIERLE,
Assistant Engineer.

General WM. F. SMITH,
United States Agent.

SUPPLEMENTARY REPORT ON PRELIMINARY EXAMINATION OF APPOQUINIMINK CREEK, DELAWARE.

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., October 26, 1888.

GENERAL: In order to more fully comply with the instructions contained in the letter from the office of the Chief of Engineers of September 29, 1888, I have the honor to submit the following in addition to my report of October 18, 1888, upon the preliminary examination of Appoquinimink Creek, Delaware.

The cost of the desired improvement, consisting of the removal of shoals, the rounding off of several sharp bends, and dredging of three new cuts, in order to straighten the creek to a depth of 6 feet below mean low water, would, in my opinion, be about $22,000.

Very respectfully your obedient servant,

WM. F. SMITH,
United States Agent.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

SURVEY OF APPOQUINIMINK CREEK, DELAWARE.

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., November 23, 1889.

GENERAL: I have the honor to transmit herewith a copy of a report of the survey of Appoquinimink Creek, Delaware, of Mr. A. Stierle, assistant engineer. This survey was provided for in the river and harbor act of August 11, 1888.

The project and estimates of Mr. Stierle are indorsed as proper and reasonable.

A tracing of the map of the survey is sent by mail to-day in a separate package.

Very respectfully, your obedient servant,

WM. F. SMITH,
United States Agent.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. A. STIERLE, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., November 23, 1889.

GENERAL: I have the honor to submit herewith a report upon the survey of Appoquinimink Creek, Delaware, and a project for its improvement.

The survey shows that next to the Christiana River, Appoquinimink Creek is, for

its length, the largest stream in Delaware if the tidal considered. The course of the creek is like that of all marshy land, very tortuous, and covers a total distance to the town of Odessa, near the head of navigation. fourths of a mile above this place.

At the entrance into the Delaware River the creek is flats, extending one-half of a mile from shore, with only mean low water. No distinct channel or drain exists mouth to New Bridge, a distance of 4½ miles, the averag the banks is 200 feet. Above New Bridge the width is tween 220 and 160 feet. At Odessa the creek is at some been built, only 90 feet wide.

The average depth at mean low water of the deepest p called "The Thalweg," is 11½ feet from the mouth to Od the creek, 8¾ miles, the last mile of the upper section has that of the remaining miles being 12.3 feet, with the av within the first mile above the mouth.

The creek is bordered upon each side by low marshes, undulations of cultivated land approach. The bottom hard, fine sand, intermixed with beds of gravel and cl water is interrupted by a bar consisting of large stones with clay and too hard to be removed by the currents.

Simultaneous tidal observations were made for a peri New Bridge, and Rock Landing, supplemented for sever the mouth of the creek. The average rise and fall of th 4.23, 5.70, and 6.08 feet at those places, respectively. wave travels from Rock Landing, which is a mile fro a distance of 19,500 feet, in fifty minutes; from New of 18,500 feet, also in fifty minutes. The low water arri six minutes after passing Rock Landing, and at Ode after passing New Bridge. The progress of the high throughout the creek. That of the low water, howev many bends in the lower section. It is safe to assum wave moves, in the present case, very nearly in a ho each gauge, their values and distances between them, the low-water slope from Odessa to Rock Landing is fo of 0.075 foot per 1,000, and from the latter place to or at the rate of 0.055 foot per 1,000. The average du to be, at Rock Landing, five hours and twenty minute and eleven minutes, and at Odessa, five hours and t duration of ebb at the same points was seven hours and and twelve minutes, and seven hours and twenty minut ble tidal conditions exhibited by the results of these ob creek admits of being much improved at little expen after the execution of the project herein submitted, th will be lowered from 2 to 3 feet, and the rise and fall increased.

The most serious obstructions to the progress of the navigation of the creek, are the many sharp bends w section. Several of these should be rectified by the dre be improved by the removal of projecting points. The for an 8-foot low-water channel 100 feet wide, from th above, and 80 feet wide the remaining distance to the steady growth of commerce and an increasing navigatio sels, it is probable that at no distant day a deeper chan and that the creek above the bridge will have to be imp convenient landing purposes.

The dredging necessary will mainly consist in widenin cially at the bends. From about one-half of a mile below posed channel will require continuous cutting for the fu average depth of 4 feet. The lines of dredging are to the curved lines indicated on the map.

Three new cut-offs of a total length of 2,500 feet are the citizens is to be widened. If no cut-offs are made th rial to be dredged to make a channel of the dimensions yards. If the cut-offs are added to the estimate this 132,960 cubic yards.

For information as to the present and future com respectfully refer to the preliminary report previously su

Estimate.

Dredging along present course of creek for a channel 8 feet deep at low water and 100 feet wide to above new bridge, and 80 feet wide to bridge at Odessa, 154,060 cubic yards, at 15 cents	$23,109
Deduct amount not required to be removed if cut-offs are made, 20,600 cubic yards, at 15 cents	3,000
	20,019
Add for cut-offs, 132,960 cubic yards, at 15 cents	19,944
Total estimated cost of project	39,963

Very respectfully, your obedient servant,

A. STIERLE,
Assistant Engineer.

General WM. F. SMITH,
United States Agent.

H 17.

PRELIMINARY EXAMINATION OF WICOMICO RIVER, MARYLAND.

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., December 26, 1888.

GENERAL: In compliance with the requirements of section 14 of the river and harbor act of August 11, 1888, and the instructions contained in the letter of September 29, 1888, from the office of the Chief of Engineers, I have the honor to submit the following report upon the preliminary examination of Wicomico River, Maryland, made under my direction by Mr. A. Stierle, assistant engineer.

The Wicomico River has been the subject of improvement with such beneficial results to commerce and navigation that the interests of the locality demand a wider and deeper channel.

For the reasons and facts given in the report of the assistant engineer, a copy of which is herewith inclosed, I deem Wicomico River, Maryland, worthy of improvement, and recommend a survey of it from White Haven, Md., to Salisbury, Md., a distance of about 12 miles.

A rough estimate of the cost of the desired improvement is $30,000.

The least amount required to make the survey, with report and estimate of cost of improvement, is $600.

Very respectfully, your obedient servant,

WM. F. SMITH,
United States Agent.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. A. STIERLE, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., December 26, 1888.

SIR: In compliance with your instructions, I have the honor to submit the following report upon the preliminary examination of Wicomico River, Maryland:

The Wicomico River flows in a southwesterly direction through Wicomico County, eastern shore of Maryland, and is a tributary of Chesapeake Bay, entering the head

of Tangier Sound from the east. Before it unites with the sound its well-defined channel meanders across a wide and shallow sheet of water called Monie Bay, which, however, is nothing more than a broad expansion of the mouth, characteristic of all rivers on the Chesapeake Bay. The headwaters of the Wicomico rise near the elevated rim or edge which encircles the Great Cedar Swamp, situated within the lower section of Sussex County, Del. It is stated that none of its feeders penetrate this rim and drain any of the waters of this swamp; they drain, however, about 49 square miles of mainly forest country and contribute a comparatively small but steady inflow of fresh water, which is little subject to very sudden changes in volume and not surcharged with sediment.

The total length of this upper or fresh-water section of the river is about 12 miles.

The estuary or tidal portion extends, as is usual with the rivers of the Peninsula, from the bay to the lowest mill-dam, which in this case was built across the bed of the river at the town of Salisbury, 23 miles above the mouth. The total length of Wicomico River is, therefore, about 35 miles. The width between low-water marks is 4,600 feet at the entrance into Monie Bay. From there it gradually diminishes to 550 feet at a point about 2 miles below Salisbury.

Near this town and for some distance below it the former width of the river has been reduced by artificial structures to 150 feet. There exists at present a clear and unobstructed channel depth of 7 feet to Salisbury, the head of navigation. The depth in the lower section of the river varies from 12 to 40 feet.

The rise and fall of the tide is about 3½ feet at the mouth and about 3 feet at Salisbury.

That portion of the river immediately at and below Salisbury has been under improvement by the United States since 1872. At that time the navigable channel, with a least depth of about 8 feet at low water, extended to within 2 miles below Salisbury. The remaining section to the mill-dam was quite shoal; with an average depth of only 12 inches at low tide. This shoal portion was a natural accretion of several causes consequent upon the construction of the mill-dam, as, for example, the entire stoppage of tidal currents, the tide merely rising and falling, and facilitating the deposit of sediment and material swept down from the upper river by drainage and freshets and by the breaking of temporary sand-dams. All these causes of deterioration were greatly augmented by the river being made a receptacle for all refuse matter from the adjacent numerous saw-mills. The proposed improvements, projected by Colonel Craighill, Corps of Engineers, in 1872, contemplated the dredging of a channel 75 feet wide and 7 feet deep at mean low water through this shoal and the contraction of the water-way by dikes. The width was subsequently increased to nearly 100 feet and the dredging of a turning basin was added. The project was completed in 1885, after the sum of $50,000 had been expended, and the effects of the improvement upon the commerce of the river have been of the most beneficial and stimulating character.

It is but just to add that the citizens of Salisbury have supplemented at their own expense, and at a cost of $25,000, the improvements undertaken by the General Government, by dredging a large section of the river above the draw-bridge to a depth of 7 feet and by defraying a certain portion of the expense of constructing dikes. Other improvements made by different individuals along the river front, such as the construction of bulkheads, wharves, and locks, etc., have been upon a large scale and very costly. The great benefit which the people and the wonderful stimulus which the trade of the whole region of the Wicomico derived from the improvement of the river can best be illustrated by the following facts: In 1871 the assessed value of all real and personal property within the town limits of Salisbury was $806,830, and at the present time it is $1,518,280. The corporate spirit, which in 1871 was awakened from its long lethargic sleep and which at that time could not afford to expend more than $645.46 for internal improvements and general town expenses, has been imbued with new life, and the sum of $5,319.16 was expended for those purposes in 1888.

The value of all the goods held by the merchants of the town in 1871, according to the records of the license clerk, was $109,000. It has increased, as shown by the same records, this year to $379,000. It is estimated that the total sales of merchandise in 1871 did not exceed $550,000; this year they have reached the large amount of $2,490,000.

The above figures speak for themselves, and were carefully compiled by Mr. E. Stanley Toadvin, attorney of Salisbury, who also kindly furnished the following commercial statistics:

"In 1871 there were no factories here and but three saw-mills and two grist-mills, doing a custom business which would in all not amount to over $60,000 per year and did not employ over 25 or 30 hands. Since 1886, the year of the great conflagration, Salisbury has been nearly rebuilt, and its stores, dwellings, and churches would be an ornament to any city. With these improvements, caused by the fire, came electric-

light and water works, costing over $50,000. The increase in the leading lines of business from 1871 to 1888 has been as follows:

Coal, from 4,000 tons to	tons..	20,000
Groceries, at the rate of	per cent..	100
Hardware, at the rate of	do....	700
Dry goods, at rate of	do....	400
Notions, etc., at the rate of	do....	400
Clothing, boots, and shoes, at the rate of	do....	500
Fertilizers, at the rate of	do....	600
Furniture, etc., at the rate of	do....	600

"The lumber brought here and reshipped to various places amounts to between 30,000,000 and 35,000,000 feet.

"Manufacturing is also increasing, and Salisbury now has three large planing mills, four saw-mills, one kindling-wood factory, two basket and crate factories, three merchant grain mills, two canning factories, one fertilizer factory, one hominy, grain, and shell mill, three brick-yards, one machine-shop and foundry, one door, sash, and molding factory, and several other factories will be established by next spring.

"The shipment of strawberries, fruits, and vegetables has increased to such an extent that the Maryland Steam-boat Company had to put another large steamer on the route from here to Baltimore last year to enable them to handle the trade. Before the improvement of the river there were no shipments of berries, fruits, and vegetables by water and very little grown in the country bordering on the river, but now lands on both sides, from its headwaters at Salisbury to its mouth at Nanticoke Point, are being largely planted in peaches, fruit, and vegetables. The filling up of the river at Salisbury would destroy all these improvements and industries, for, if the town was cut off by it, the steam-boat line would be discontinued and the business of Salisbury would be seriously injured."

It is stated that the passing of steamers and other vessels has washed the banks of the river, wherever they are not protected by dikes, to such an extent that the dredged channel has been reduced in width and depth at various points, greatly to the detriment of navigation. An examination made last summer shows that there are only three places, and those only within the section confined by dikes, where encroachments upon the channel have occurred through the giving away of portions of the dikes that are fast deteriorating, and through the washing in of considerable material at the outlet of a large drain. It is said that on account of these shoals vessels drawing over 6½ feet are compelled to wait for the tide to rise before they can make the harbor at Salisbury.

During the past two years the necessity for an enlargement of the harbor and an increase in the dimensions of the channel leading thereto with regard to width and depth has become more and more apparent.

The commerce of the river has evidently reached the limit of the carrying capacity of the present channel and the demand is now made that improvements should be resumed upon a new and more extensive basis, as warranted by the wonderful growth of the commerce of the Wicomico, that followed its first improvement. A channel 9 feet deep at mean low water is desired, with a clear width of 100 feet, to a point 2,000 feet below the draw-bridge at Salisbury, and 150 feet wide up to the dock of the Maryland Steam-boat Company. Within the latter section this project would require the removal of a portion of the old dikes and the sloping back of the artificial banks previously made. From present indications it is supposed that such an improvement would be ample and remain permanent for a long time to come.

No survey of the river below the improved section has ever been made, but it is stated that the 9-foot curve does not extend beyond Sharp's Point, or nearly 3 miles below Salisbury. Taking this as a basis, it is roughly estimated that a channel of the above dimensions would require the removal of about 110,000 cubic yards of material at a probable cost of $30,000.

In view of its present importance and its growing wants in the future, I would respectfully recommend a survey of the river from White Haven to Salisbury, a distance of about 12 miles, which can be made for $600.

Very respectfully, your obedient servant,

A. STIERLE,
Assistant Engineer.

General WILLIAM F. SMITH,
United States Agent.

SURVEY OF WICOMICO RIVER, MARYLAND.

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., November 27, 1889.

GENERAL: In compliance with the instructions contained in the letter of April 6, 1889, from the office of the Chief of Engineers and the requirements of the river and harbor act of August 11, 1888, I have the honor to submit the following report upon the survey of Wicomico River, Maryland, made under my directions during the past summer.

The permanency of the work already done in this river suggests the following project for the future improvement, viz, to dredge a channel to 9 feet in depth at mean low water from the natural 9-foot curve to the draw-bridge at the town of Salisbury. This would require the removal of about 116,000 cubic yards of material at an estimated cost of $23,200.

A copy of the report of Mr. A. Stierle, assistant engineer, is herewith inclosed. A tracing of the map* of the survey is sent by mail to-day in a separate package.

Very respectfully, your obedient servant,

WM. F. SMITH,
United States Agent.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. A STIERLE, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., November 27, 1889.

GENERAL: I have the honor to submit herewith a report upon the survey of Wicomico River, Maryland, and a project for its improvement.

The section of the river from the town of Salisbury to a point 2 miles below has been improved before at various times by the General Government. The improvement proved to be a great success, and resulted in a flourishing commerce on the river, so that a demand for a deeper channel was presented. The depth to which the river was previously improved was 7 feet below mean low water. A channel 9 feet in depth at the same stage of tide is now asked for.

The survey was made for the purpose of ascertaining the precise locality where the 9-foot curve, coming from the river below, closes, so that a proper estimate could be made for a channel of that depth and of suitable width. The examination commenced at Salisbury on July 16 last, and was gradually extended down the river during the remainder of the month, until this point was definitely located, near Goose Island Wharf, about two miles below the town. The length of river examined was 4 miles. About 2,500 feet below Sharp's Point, where the survey ended, the 9-foot channel is 190 feet wide. This width becomes gradually narrower further up the river, and is less than 100 feet above Fruitland Wharf for a total length of 750 feet. Continuing above this point, the channel is of a uniform width of 100 feet as far as Goose Island Wharf, where the 9-foot curve closes. Depths slightly in excess of 9 feet appear again in long and narrow pockets—seven in number—from here to the bridge at Salisbury. The average depth below mean low water in that portion of the channel which is less than 9 feet deep is 8 feet.

The survey shows, when compared with the map of the examination made in July, 1888, that very little shoaling is going on within the present channel, which had been dredged to 7 feet, the last time in 1885. At a few points the material washed down from the adjacent banks or from behind the old dikes has caused a slight contraction in the channel width, but generally the results of the improvements are more favorable and permanent than was ever anticipated.

Tidal observations were made during the progress of the survey from July 16 to August 1, inclusive, at Salisbury Bridge and Fruitland Wharf, or Shad Point. The rise and fall of the tide at each of these places, which are 4 miles apart, were found to be the same, namely, 3 feet. On account of a lack of sufficient data relating to

---

*Omitted.

former years, I have not been able to make a comparison between the changes in the tidal conditions that have taken place in the upper river since improvements were commenced in 1872. This would be interesting information to have, especially as to its future application to other and similar cases.

The question of enlarging the present channel is, in view of former improvements, a very simple proposition.

The project herewith submitted is for dredging a channel 9 feet deep at mean low water and 150 feet wide, beginning near Fruitland Wharf, in continuation of the natural 9-foot channel from below, between the dikes and wharves already built and extending to the draw-bridge at Salisbury.

The amount of material, which is mainly fine sand, to be removed under this project is estimated at 116,000 cubic yards.

For information referring to the commerce of Wicomico River, I would respectfully invite attention to the full and complete statistics appended to the preliminary report submitted in December last.

ESTIMATE.

For dredging a channel 9 feet deep, at mean low water, and from 100 to 150 feet wide, from Fruitland Wharf to the draw-bridge at Salisbury, 116,000 cubic yards, at 20 cents, $23,200.

Very respectfully, your obedient servant,

A. STIERLE,
Assistant Engineer.

General WM. F. SMITH,
United States Agent.

H 18.

PRELIMINARY EXAMINATION OF NORTH EAST RIVER, MARYLAND.

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., November 8, 1888.

GENERAL: In compliance with the requirements of section 14 of the river and harbor act of August 11, 1888, and the instructions contained in the letter from the office of the Chief of Engineers of September 29, 1888, I have the honor to submit the following report upon the preliminary examination of North East River, Maryland, made under my direction by Mr. A. Stierle, assistant engineer.

For the reasons and facts given in the report of Mr. Stierle, a copy of which is inclosed herewith, I deem North East River worthy of improvement and recommend a survey of it.

The cost of the desired improvement would be about $12,000. The least amount required to make the survey with report and estimate of cost of improvement is $100.

Very respectfully, your obedient servant,

WM. F. SMITH,
United States Agent.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. A. STIERLE, ASSISTANT ENGINEER,

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., November 8, 1888.

SIR: In compliance with your instructions I have the honor to submit the following report upon the preliminary examination of North East River, Maryland.

North East River is, with the exception of the Susquehanna River, the most northerly tributary of the *Chesapeake Bay*. It is formed by two branches, the Great and

Little North East Creeks, that flow due south, and whose sources lie upon the eastern slope of the Allegheny Mountains, within Chester County, Pa.

After the junction of the two branches, near the town of Northeast, Md., the river flows in a southwesterly direction, and gradually expands into a broad estuary to its entrance into the bay. The length of each of the two branches to their junction is about 14 miles, their physical characteristics being entirely those of mountain streams. From about 1 mile below the junction to the mouth the river is under tidal influences and is about 5½ miles long. Within the estuary the width varies from one-quarter of a mile to 2 miles, and the depth of water is on an average 8 feet, except upon the bar at the upper end. The width of the river proper from this bar to the bridge on the northern extremity of the town of Northeast, a distance of about 1 mile, is from 150 to 600 feet. This latter section constitutes the head of navigation, and the town is built along its eastern bank. The depth of the channel within it is said to be about 7 feet, with a variable width of not less than 30 feet; the average rise and fall of the tide about 2½ feet.

The present obstruction is stated to be the shoal water over the bar below the town, with a depth of only 2½ feet at mean low tide. No other serious obstruction exists.

The river has previously been under improvement by the General Government. In the years 1872–'73 and 1880–'81, appropriations of $10,000 and $5,000, respectively, made by Congress, were expended in the improvement of the channel from the bar above referred to, to Alexander's Mill, above Church Point Landing. The result of the first expenditure was a channel 5 feet deep at mean low water from the 5-foot curve near the mouth of the river to the wharf at Northeast, and a turning-basin in front of the wharf 120 feet square, and a channel 25 feet wide and 3 feet deep from the wharf to Alexander's Mill. The second appropriation was expended in increasing the depth of the channel previously made to from 5½ to 6 feet, in enlarging the turning-basin and deepening it to 8 feet, and in dredging to a depth of 10 feet a deposit of sand and mud opposite the confluence of a small stream just below the wharves.

It appears that the bar below the town has again shoaled. This was, in a measure, anticipated when the improvements just mentioned were carried out, and there is no doubt that the commerce of the North East River will be considerably affected if the shoals are not removed. What the proper remedies should be to make any future improvements permanent can not be decided until a survey is made.

The town of Northeast is located in Cecil County, Md., and is one of the oldest settlements on the Chesapeake. It is a thriving business place, surrounded by a rich agricultural country, and has a population of from 1,500 to 1,600.

It has thirty different stores, one large rolling-mill, two fire-brick companies, one steam saw-mill, one flouring-mill, one pottery, one basket factory, one razor-strop factory, one carriage factory, one chemical factory, and three canning houses. Nearly all the raw and finished products imported and exported by these manufacturing establishments are received and shipped by rail.

An average of five hundred vessels of the smaller class land at Northeast during the year. About five vessels, from 25 to 50 tons burden, are owned in the town.

The imports by rail and water are given as follows:

Five hundred thousand feet, B. M., lumber; 400,000 shingles; 3,000 to 5,000 cords pine wood, mostly used by the chemical works; 500,000 fire-brick, clay; fertilizers to the value of $50,000; oysters to the value of $3,000; water-melons to the value of $3,000; fish to the value of $6,000.

There are exported 2,000 bales of hay and grain and country produce to the value of $200,000.

I could obtain no accurate information as to the amount and value of the productions of the different manufactories and works above mentioned; the same must be said of the general merchandise and other valuable freight, which must be large.

The improvements already made in the river have been of great value to the shipping interest at Northeast, and have resulted in a decrease of freight rates by rail and water. The general trade would be still more benefited by the removal of the bar above referred to, as vessels of a larger class could enter more readily, and a regular steam-boat line to Baltimore is contemplated.

It is approximately estimated that a channel through the bar 100 feet wide and 7 feet deep at mean low water would cost $12,000.

An examination (survey) of the river from the bar to the wharves at Northeast could be made for $100.

Very respectfully, your obedient servant,

A. STIERLE,
Assistant Engineer.

General WM. F. SMITH,
United States Agent.

SURVEY OF NORTH EAST RIVER, MARYLAND.

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., November 26, 1889.

GENERAL: In compliance with the instructions contained in the letter of June 19, 1889, from the Office of the Chief of Engineers and the requirement of the river and harbor act of August 11, 1888, I have the honor to submit the following report of the survey of North East River, Maryland, with a copy of the report of Mr. A. Stierle, assistant engineer, containing a project for the improvement of the river and estimate of cost of proposed improvement.

In comparing the map of this survey with the condition of the river when the last work was done in 1881, it would appear that the ebb tides are not sufficiently strong to keep the sediment from being deposited throughout nearly the entire length of the river, and that constant dredging will be required to keep the channel of a proper depth to benefit the commerce on the river.

If money should be appropriated for improving the river it is recommended that a channel be made 75 feet wide and 6 feet deep at mean low water across the bar at the mouth and to the mouth of Stony Run, and from that point to the head of navigation the channel be made 60 feet wide, with the low-water depth of 6 feet.

The estimated cost of this improvement is $5,140.

A tracing * of the map of the survey is transmitted by mail to-day in a separate package.

Very respectfully, your obedient servant,

WM. F. SMITH,
United States Agent.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. A. STIERLE, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., November 25, 1889.

GENERAL: I have the honor to submit herewith a report upon the survey of North East River, Maryland, and a project for the improvement of the same.

This river has previously been under improvement by the General Government just below the town of Northeast. The survey, which was made during the present month, embraced, therefore, that portion of the river which was dredged at various times, the last time in the spring of 1881.

At the close of operations that year a channel existed below the wharves of the town from 5½ to 6 feet deep at mean low water, with an average width of 50 feet, and extending across the bar to deep water beyond. A turning-basin about 300 feet long and 100 feet wide had also been dredged in front of the wharves to a depth of 8 feet below mean low water.

The results of the present examination show the following condition of these improvements: About two-thirds of the area of the turning-basin has shoaled in the upper portion to an average depth of 3 feet; the original depth within its lower portion remains. The dredged channel has slightly shoaled and narrowed from the wharves to a point about 800 feet below the mouth of Stony Run. Beyond that point the channel has entirely disappeared, most of the shoaling having taken place at the upper end, where for a distance of 1,000 feet the average depth along its former direction is now 4 feet, indicating a decrease in depth of from 1½ to 2 feet. The 6-foot curve of deep water in the lower river, which at the time above referred to appeared at a point 2,850 feet from Stony Run, has receded considerably, and was located by the present survey 1,700 feet farther down the river. This receding movement, as far

*Omitted; printed in House Ex. Doc. No. 21, Fifty-first Congress, first session.

as it has gone, was due to a general shoaling of about four-tenths of a foot in depth and may be a gradual one; the greatest shoaling on the top of the bar, however, took place, as is reported, soon after the dredging was done.

There would appear no difficulty, perhaps, to maintain a channel across the bar for a much longer time than could be done by dredging by constructing parallel dikes along the cut. In view of the fact, however, that the bottom of North East River is very flat as far as its entrance into Chesapeake Bay, and that these dikes would need constant repairs and constant extension, on account of a certain reformation of a bar at their lower ends, a project for such an adjunct is hardly warranted; nor would the outlay of money required for it be commensurate with the present and future commerce of the river. Periodical dredging is evidently the cheapest remedy for the existing obstructions to navigation.

Although a desire was expressed by those interested in the improvement of the river that a 7-foot channel should be dredged, no estimate for one of that depth has been made, for the reason that the length of cut required would be nearly two miles. The estimate herewith submitted is for a 6-foot low-water channel 75 feet wide from the 6-foot curve outside the bar, following the lines of the channel previously made, to opposite Stony Run, and for a channel of the same depth, but only 60 feet wide, to Davis Wharf. The length of the cut to be made across the bar will be about 3,800 feet; the estimated amount of material to be removed under the project is 25,700 cubic yards.

I would respectfully refer to the preliminary report for information as to the commerce of the river.

ESTIMATE.

For dredging a channel 6 feet deep at mean low water, 75 feet wide across the bar, and 60 feet wide to Davis Wharf, 25,700 cubic yards, at 20 cents, $5,140.

Very respectfully, your obedient servant,

A. STIERLE,
Assistant Engineer.

General WM. F. SMITH,
United States Agent.

H. 19.

PRELIMINARY EXAMINATION OF CHESTER RIVER BETWEEN CRUMPTON AND JONES'S LANDING, MARYLAND.

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., January 22, 1889.

GENERAL: In compliance with the requirements of section 14 of the river and harbor act of August 11, 1888, and the instructions contained in the letter of September 29, 1888, from the office of the Chief of Engineers, I have the honor to submit the following report upon the preliminary examination of Chester River between Crumpton and Jones's Landing, Maryland, made under my direction by Mr. A. Stierle, assistant engineer.

In view of the facts and reasons set forth in the detailed report of Mr. Stierle, a copy of which is herewith inclosed, Chester River between Crumpton and Jones's Landing is in my opinion worthy of improvement and a survey is recommended.

A rough estimate of the cost of the desired improvement is $33,000.

The least amount required to make the survey, with report and estimate of cost of improvement, is $350.

Very respectfully, your obedient servant,

WM. F. SMITH,
United States Agent.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. A. STIERLE, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., January 22, 1889.

GENERAL: In accordance with your instructions, I have the honor to submit the following report upon the preliminary examination of Chester River between Crumpton and Jones's Landing, Maryland:

Chester River has its headwaters in Kent County, Del., and flows in a general southwesterly direction into Chesapeake Bay. It is the boundary line between Kent County on the north and west and Queen Anne County on the south and east, these two counties being the most northerly on the Eastern Shore of Maryland. The total length of the river is about 50 miles, and it is navigable for vessels drawing not over 7 feet of water as far as Crumpton, 37 miles from the mouth. The examination called for embraces the section of the river lying between Crumpton and Jones's Landing. The accurate location of this landing could not be ascertained, as there is no landing, properly speaking, of this name, and opinions seem to differ as to the exact point where a former lime landing of that name existed. It is stated, however, that a certain turn in the river, about three-fourths of a mile below the town of Millington, was the objective point in view when the petition for the removal of the obstructions was framed.

The distance from the bridge at Crumpton to Millington, measured along the course of the river, is nearly 5 miles; to Jones's Landing it would, therefore, be about 4¼ miles. For about 1¼ miles above Crumpton the width of the river varies from 800 to 1,200 feet, the average depth of water in the channel being nearly 7 feet at mean low tide. The channel is narrow, being flanked on either side by broad, shallow flats. The width of the remaining section, to Jones's Landing, is more contracted, and does not exceed 200 feet, the channel depth also being reduced to an average of 4 feet. The least depth of water in the channel throughout the whole section examined is about 2 feet; the maximum depth, about 11 feet. In the upper portion deep holes and shoals follow each other. This irregularity in the profiles of the bottom, longitudinally as well as crosswise, appears to indicate a rather wild condition of the river, which is not unusual and is characteristic of the upper portions of unimproved tidal streams. The bottom is said to be fine sand, gravel, and "iron rock." The tide rises, on an average, 2 feet at Crumpton and 18 inches at Millington, the fluctuations being, however, very irregular. There is a mark shown on a house near the bridge at Millington up to which an unusually high storm tide had risen many years ago, the mark appearing to be about 10 feet above the general level of the river. It may be assumed from this fact that the high-water plane is not much higher at the head of the river than in Chesapeake Bay, and that the tidal conditions at least are susceptible of considerable improvement.

That portion of Chester River from Crumpton up to Kirby's Landing, a distance of about 3½ miles, was surveyed under the direction of Col. Wm. P. Craighill, Corps of Engineers, U. S. Army, in 1880, and a project made for a channel 6 feet deep at mean low water and either 50 or 65 feet wide, but the improvement was never commenced.

Crumpton is the highest stopping-place for all steam-boats; small sailing vessels go as far as Kirby's Landing. The upper part of the river has no navigation. Anomalous as it may seem, in a country so full of splendid water-ways, there is adjoining here an area of highly-cultivated land of about 240 square miles, extending 4 miles north towards the Sassafras and 11 miles south of Chester River toward the Tuckahoe and Choptank rivers and 16 miles east of Crumpton as far as Duck and Little creeks in Delaware, which is practically without an outlet to market by water for its rich and various productions. In this respect the farmers are entirely dependent upon facilities for transportation furnished by railroads which lead principally to northern markets. They are cut off in a manner from the advantages which direct communication with the Baltimore market offers. The freight on grain, for instance, is from 7 to 8 cents per bushel to Philadelphia by rail; to Baltimore by water it is only 4 cents. For this reason, and where the hauling distance is not too great, much grain is taken to and shipped from the nearest shipping points on adjacent rivers, but the bulk of it, in addition to all fruit, such as peaches, pears, and berries, of which an abundance is raised, goes by rail. This shows that every mile which is added to the navigable channel of Chester River would be of great and incalculable benefit to the surrounding country.

The town of Millington, in Kent County, is the center of the large section of country which is interested in the improvement of the upper portion of Chester River. This place is a station on the Queen Anne and Kent Railroad, and has between 1,500 and 1,600 inhabitants. There are located here twenty general stores, one grist mill, two canning-houses, and one basket factory. It is an old and conservative settlement that has grown to its natural limits unless navigation should be extended to or nearer to it, in which case it is said trade would receive a new impetus and would be

followed by the establishment of numerous factories e
related to agricultural interests. The country around i
and still posesses small tracts of valuable ship-timber.
during the past year, approximately estimated, 500,00
baskets of peaches, 35,000 dozen eggs, 50 tons poultry, 10,
bushels of lime, and general merchandise to the value of

The desire of the people interested in the movemen
Chester River is that a 7-foot channel be made from Cru
It is inferred from information received that the add
three-fourths of a mile long and extending to the bridg
cluded in the request for improvements, for economical
much desired.

The amount of material to be removed in dredging a
low water, and about 50 feet wide between the points ex
imperfect information obtained, at 100,000 cubic yards
$33,000.

This improvement would seem to have special merit,
country needs it in order to carry on trade and comme
fact that with an increased tidal volume the opening of
only beneficially upon the lower sections is an important
sight of.

A survey of the section of the river referred to in this
probable cost of $350.

Very respectfully, your obedient servant,

Gen. WM. F. SMITH,
United States Agent.

SURVEY OF CHESTER RIVER BETWEEN CR
LANDING, MARYLAND.

UNITED STATES EN
Wilmington,

GENERAL: In compliance with the instructio
ter of April 6, 1889, from the office of the Chief o
quirements of the river and harbor act of Aug
honor to submit the following report upon the s
between Crumpton and Jones's Landing, Mar
direction during May and June, 1889.

The project as developed by the survey and r
provement of the Chester River from Crumpton
heretofore known as Jones's Landing, Maryland

To dredge a channel from Crumpton to a poi
ton, 60 feet in width and 6 feet deep at mean lo
of 51,000 cubic yards of material, at 25 cents pe

A copy of the report of Mr. A. Stierle, assista
inclosed.

A tracing of the map* of the survey is sent
arate package.

Very respectfully, your obedient servant,

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

---

* Omitted.

REPORT OF MR. A. STIERLE, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., December 7, 1889.

GENERAL: I have the honor to submit herewith a report upon the survey of Chester River, Maryland, between Crumpton and Jones's Landing, made under your direction, and a project for the improvement of the same.

Chester River is one of the largest rivers of the Eastern Shore of Maryland, and enters Chesapeake Bay from the east. It is 40 miles long and entirely a tidal stream. The commerce of the river is quite brisk within the lower 25 miles and as far as Chestertown, the channel being nowhere less than 10 feet deep and of ample width. The channel depth above Chestertown gradually decreases until it is only 6 feet near Crumpton, a small village 33½ miles above the mouth and the present terminus of steamboat navigation. A few small sailing vessels sail occasionally from a wharf about 4 miles above Crumpton; but beyond that point navigation is interrupted by many shoals, with only 3 and 4 feet of water over them.

The influence of the tide extends to Millington, situated at the head of the river and near the junction of two small fresh-water branches, Cypress Branch and Sewell's Branch, each nearly 6 miles long.

The survey was made during the months of May and June, 1889, and embraced that portion of the river lying between the bridge at Crumpton and the bridge at Millington. The latter place is nearly a mile above the assumed location of Jones's Landing, which, as stated in the preliminary report, could not be accurately located on account of non-existence. The small additional expense involved in extending the survey to Millington, the head of tidal influence, was amply repaid by the additional information obtained in relation to the physical conditions of the whole river.

The length of the river surveyed is 6½ miles; 4 miles of the shore were triangulated, the rest was determined by transit lines. In addition, a line of levels was run to connect the different tidal stations. For 2 miles above Crumpton the river retains its characteristic feature of a very wide stream with a narrow channel winding in easy curves along the middle. At this point, however, it changes its character entirely and contracts suddenly, the extensive flats on each side of the channel disappear and are replaced by narrow borders of marsh lands, inundated only during very high tides, or by the sloping hills on both shores which approach here more closely. Within a section about 1 mile in length and immediately below Crumpton Bridge, the width between the shores of the river varies between 900 and 2,000 feet. Above the bridge it varies between 600 and 1,300 feet up to the point where the sudden contraction, above referred to, takes place. The width of channel between the 4-foot curves in both sections just named is upon an average 200 feet, at the widest place not over 300 feet.

From the south shore near Crumpton a spur of high land projects well into the heretofore wide river valley and approaches the high bank on the north shore to within 900 feet. A wooden bridge 210 feet long, with a draw 37 feet wide, crosses the river at this point; the approaches on the south side consisting of a causeway originally laid upon the river flats and finally raised to a height of about 4 feet above water-level. The distance between the shore-lines where the bridge is located can not have been less than 700 feet before the latter was built; the construction of the bridge and the embankment of the causeway, however, have reduced the width to practically 200 feet.

The great injury done to the river above Crumpton, and indirectly also to the section immediately below the town, by this sudden contraction of water-way and consequent diminution in the strength and volume of tide, is obvious.

At the point where the river narrows, about 2 miles above Crumpton, its course, which heretofore has been fairly straight, becomes more sinuous, with occasional deep, cove-like expanses at the turning points of the bends. These coves are shallow and are rapidly filling up. The width between the shores in the section of the river from this point to Millington averages 235 feet; maximum width being 350 feet, minimum 120 feet. Notwithstanding this sudden reduction in width, the depth in the channel above increases but little. The average of the maximum depths below mean low water, from the bridge at Crumpton to the point referred to, 10,500 feet above, is 8 feet; the mean depth in all the cross-sections is 3.37 feet. The corresponding depths for the remaining upper section of the river, from this point to Millington Bridge, a distance of 23,900 feet, are: For the channel, 6 feet; for cross-sections, 3.31 feet. The average depth in the channel following the line of the "thalweg," as far as surveyed, is 6.7 feet; the mean depth of all cross-sections is 3.33 feet; the deepest water is 14,000 feet above the bridge and is 13.3 feet.

The change which occurs in the characteristic element of the river at the critical point mentioned, can be better illustrated by a comparison of cross-sections. Below the point the average area of cross-sections is 2,593 square feet; above it it is 750 square feet; both figures indicating nearly also the ratio of reduction in areas immed-

diately above and below the point of transition. The average area of all cross-sections is 1,387 square feet. The nearest unobstructed cross-section to Crumpton Bridge, about 100 feet above the latter, contains 2,204 square feet

The 10-foot curve coming from the lower river closes 1,100 feet above Crumpton, but appears again in three places farther up, the last time 17,000 feet above the bridge. The 8-foot curve closes 1,700 feet above Crumpton and re-appears at eleven different places between this point and Kirby's Landing, 19,000 feet above. The 6-foot closes about 1 mile above Crumpton, appears again 200 feet beyond for a distance of 2,200 feet, and being interrupted once for 650 feet, continues as far as Kirby's Landing. Above the landing it is visible at six different points in narrow pockets, the longest 800 feet, the shortest 400 feet long, the last point being about a mile below Millington.

The 4-foot curve closes one-half a mile above Kirby's Landing, where it is interrupted for 2,700 feet, after which it continues unbroken towards the head of the river for 3,000 feet more, and in eight pockets of various lengths, the longest being 1,500 feet. The 2-foot curve is continuous along each shore. The bottom of the river consists of hard sand, gravel, and stone, especially within the deepest portion of the channel, and of soft mud and clay within the shoal portions and along the shores. About 2 miles above Crumpton a deposit of "iron rock" crops out of the north bank, washed by the river, and apparently extends under the water.

It remains to give an account of the tidal observations and their result, as a basis for future reference and measurements, whether this part of the river is improved or not. These were made in a very simple manner on account of the limited means, and are believed to be reliable, notwithstanding the prevalence of rather abnormal weather during the period of observations.

Two permanent tide-gauges were established at each end of the section surveyed, one at Crumpton Bridge, the other at the bridge at Millington. The first named was a self-registering tide-gauge, inclosed in a small house, and was referred to the zero of a tide-gauge used during the survey of Chester River, made under the direction of Col. William P. Craighill, Corps of Engineers, U. S. Army, in the fall of 1880, the elevation of which was fortunately recovered. An almost continuous record of the tide was obtained from May 29 to June 30.

The tide-gauge at Millington was a plain board fastened to one of the trestles of the bridge. Observations were made during the day-time from May 18 until June 30.

The distance between the two gauges, measured along the middle of the stream, is 34,400 feet. In a river where the rise and fall of the tide is small, as in Chester River, the wind and weather have much influence upon the daily variations of the water-level. The incessant heavy rains and storms which prevailed during the progress of the survey and the consequent high and low tides and freshets, made it necessary to reject many of the observations in order to determine their mean value. Mean low water of the gauge at Crumpton reads 2.45 feet; mean high water, 4.58 feet, making the mean rise and fall 2.13 feet. The average duration of flood is 6 hours 7 minutes; the average duration of the ebb, 6 hours 18 minutes. The average duration of high-water stand is 19 minutes; that of low-water stand is 20 minutes. The highest high water observed read 5.90 feet; the lowest high water, 3.63 feet on the gauge.

In the same way the highest low water rose to 4.70 feet, and the lowest low water fell to 1.56 feet at the gauge. The greatest range of tide observed for the whole period was, therefore, 4.34 feet, or more than twice the average rise and fall. These extreme high and low waters were due to freshets and storms; in calm and fair weather, however, the local laws of the rise and fall of tide at Crumpton are nearly of a normal type, as may be inferred from the general mean values above given, and indicate but little obstruction to the progress of the tidal wave in the river below.

The gauge at Millington was so near the meeting point of tidal influence from below and fresh water inflow from above, that it becomes quite difficult to obtain any definite results from the observations made here, extended as they were over so short a period only.

It was necessary to reject all those observations containing an element not conforming to the usual conditions and to determine the means from those remaining. The mean low water at Millington gauge reads 1.91 feet; the mean high water, 3.04 feet; the mean rise and fall of the water is, therefore, 1.13 feet. With the incoming tide the water-level rises for 5 hours and 5 minutes and then subsides for 7 hours and 20 minutes, counting both periods from the middle of one stand to the middle of the next; the duration of stand at high water being 50 minutes, that at low water, 1 hour and 50 minutes. Considering the variable conditions upon which these means depend, it is clear that if the least change takes place in them, the figures above given will be materially altered. The amount of fresh-water inflow at Millington was approximatdly ascertained.

The velocity at the bridge was calculated from data published in Col. William P. Craighill's report upon a survey for a ship-canal between Chesapeake and Delaware

bays (Report of the Chief of Engineers, U. S. Army, 1883, page 727), which gives elevations of the water-level of Sewell's Branch, the main feeder of the Upper Chester River. According to these data the relative slope above the junction with the river is 0.00151 feet at the time of mean low water at Millington. Applying a certain formula the mean velocity of the inflow is 1.95 feet and the discharge 399 cubic feet per second. By the use of another formula, which gives for smaller rivers with variable water-level the mean velocity as approximately proportional to the square root of the mean depth of cross-section, the velocity is 1.43 feet and the discharge 295 cubic feet per second. This quantity is measurably increased by freshets.

From simultaneous observations made on two fair days at the following-named points, it was found that the velocity of the crest of the tidal wave, or high water, from Chestertown to Crumpton, a distance of 8½ miles, is 27 feet per second. This velocity is rapidly destroyed above Crumpton and is 17½ feet at Kirby's Landing, 10½ feet at Jones's Landing, and 3.7 feet just below Millington. The velocity at the foot of the wave, or low water, between the first four points named is, respectively, 19.7, 4.8, 3.8 feet per second; above Jones's Landing it is imperceptible and too much under the influence of fresh-water inflow to be measured.

The rise and fall of the tide at Chestertown is slightly less than what it is at Crumpton. It may be assumed, therefore, that the elevation of mean low water at the former place, which was not connected with the line of levels, is correspondingly higher, probably 0.3 foot. Assuming the mean low water at Crumpton as zero, the mean low water at Millington, as determined instrumentally, is 1.29 feet higher, and by analogy the mean low water at Kirby's is 0.21 foot and at Jones's 0.54 foot above the same plane. In the same manner the mean high water at Crumpton is 2.13, at Kirby's 2.11, at Jones 2.23, and at Millington, 2.42 feet above the mean low water of Crumpton gauge. On the whole the results of the tidal observations are favorable for an extensive improvement, if need be, of this section of Chester River, and indicate that the mean low water at Millington may be lowered to nearly the same plane as that at Crumpton if the improvements contemplated in the project herewith are carried out. The improvement of the upper Chester River will be of great benefit to the fine farming region surrounding it, and will stimulate the establishment of kindred industries along the shores, if an opportunity is given to compete for lower freight rates.

It would appear from the statements in this and the preliminary report that there are technical as well as commercial reasons why the improvement when commenced should be carried to the head of the river as far as the tide flows. The expense of improving the last upper mile would only be $7,500; to comply with the order of the survey, however, the following estimate is submitted:

Estimate for dredging a channel 6 feet deep at mean low water and 60 feet wide from Crumpton to a point 1 mile below Millington, supposed to be Jones's Landing—

51,000 cubic yards, at 25 cents..... $12,750

Very respectfully, your obedient servant,

A. STIERLE,
Assistant Engineer.

General WM. F. SMITH,
United States Agent.

H 20.

PRELIMINARY EXAMINATION OF MANOKIN RIVER, MARYLAND.

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., October 24, 1888.

GENERAL: In compliance with the requirements of section 14 of the river and harbor act of August 11, 1888, and the instructions contained in the letter from the office of the Chief of Engineers of September 29, 1888, I have the honor to submit the following report upon the preliminary examination of Manokin River, Maryland, made under my direction by Mr. A. Stierle, assistant engineer.

For the reasons and facts set forth in Mr. Stierle's report, a copy of which is herewith inclosed, Manokin River is, in my opinion, worthy of improvement, and I recommend a survey of it.

The improvement at present desired would co
least amount required to make the survey and r
cost of improvement, is $900.

Very respectfully, your obedient servant,

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. A. STIERLE, ASSISTANT

UNITED STATE
Wilmingt

SIR: In compliance with your instructions, I have the
ing report upon the preliminary examination of Manokin

Manokin River is situated in Somerset County, Mar
westerly direction into Tangier Sound, Chesapeake Ba
tributaries, whose sources are all within the boundaries
of the river from the town of Princess Anne, the head of
into Tangier Sound is about 18 miles. For a distance
forms a broad estuary from 1 to 3½ miles wide, and the
width of 300 feet to within half a mile of Princess Anne
exceed 150 feet. The depth of the channel is said to be
mean low tide to the town of Princess Anne, with the e
junction of the river proper with the lower broad section
Point, where the depth is suddenly reduced to 3½ feet, fo
a bar which consists of stiff blue mud. Up to this bar
width of the channel is said to be ample for all practical p
tion the channel is in places narrow and tortuous, but
seriously impede the navigation.

The rise and fall at Princess Anne is stated to be from 2
averages 3 feet.

Manokin River flows through and is the natural out
which is thickly settled, and there are numerous landings
The soil is a mellow loam, and very productive of timber
of the river is covered with oysters, and these form one o
port. About 100 sailing vessels, which trade on the rive
its shores.

The town of Princess Anne is a station on the New Yor
Railroad. The greater portion of the products of the cou
ent shipped by rail. There is, as yet, no steam-boat or p
regular trips on account of the bar at Locust Point. T
the lightering of nearly all freights at the bar to and fr
The steamers of two Baltimore steam-boat companies rec
at two points at the mouth of the river, and, in the face
of these shipments is large and constantly increasing.

The following exports were made by rail and water fro
the Manokin River during the past year:

Fruit (dozen cans) .....
Wheat, oats, and corn (bushels) .....
Oysters, shucked .....
Oysters, in the shell .....
Small fruit and vegetables .....
Lumber .....
Live stock .....

There was imported during the same period:

General merchandise .....
Fertilizers .....

The above figures are approximate only, but I am infor
thing, underestimated, in the absence of means of obta
About 70 car-loads of fruits and vegetables are shipped
and the nearest stations of Somerset County every day d

The most important improvement desired at present is

through the bar at Locust Point. If this obstruction were removed, a line of steamers could ply regularly on the river in connection with the larger ones that make daily trips to Baltimore and other points. Sailing vessels would be able to make a greater number of and more regular trips. Lumber could then be shipped directly from the river, instead of being carried by rail to the town of Crisfield, about 8 miles below the mouth of the river, and there transferred to vessels, as must be done at present. Produce and fruits could be sent to Baltimore, the natural home market, with more expedition and less risk and expense. The oyster packing houses at the mouth of the river, which are now compelled to shuck the oysters to reduce the bulk and to haul them at heavy expense from 12 to 14 miles to the railroad, could then send them up the river to Princess Anne fresh and in the shell for shipment by rail to Northern markets.

It is estimated that about 40 per cent. of the small fruit raised each season in the region contiguous to the Manokin River perishes in the fields for want of cheaper transportation than that afforded by the railroads. It is said that all of this fruit could be exported with profit by water if no obstruction existed in the river. It is safe to say that the commerce of the river would double if a channel of sufficient depth was made across the bar at Locust Point.

The cost of such a channel 100 feet in width should not exceed $20,000, assuming that the dimensions as given above are approximately correct. Whether it would remain open or not can not be ascertained until a physical survey of that portion of the river has been made. A survey of the bar and the river to the head of navigation is recommended, and I estimate the cost thereof at $900.

Very respectfully, your expedient servant,

A. STIERLE,
Assistant Engineer.

General WM. F. SMITH,
United States Agent.

SURVEY OF MANOKIN RIVER, MARYLAND.

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., January 21, 1890.

GENERAL: In compliance with the instructions contained in the letter of July 25, 1889, from the office of the Chief of Engineers, and the requirements of the river and harbor act of August 11, 1888, I have the honor to submit the following report upon the survey of Manokin River, Maryland, made under my direction during August and September, 1889:

Taking into consideration the character of the bottom, as developed by the soundings, it would seem that a cut through the shoal part of the river from Locust Point to Sharp's Point would be likely to last for some time, and having reference also to the commerce of the river, I would recommend the cutting of a channel, by dredging, between the two points above named, 100 feet wide and 6 feet deep at mean low water, requiring the removal of about 150,000 cubic yards of material, at 20 cents per cubic yard, $30,000.

A copy of the report of the assistant engineer is herewith inclosed.

A tracing of the map * of the survey is sent by mail to-day in a separate package.

Very respectfully, your obedient servant,

WM. F. SMITH,
United States Agent.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

---

* Omitted.

REPORT OF MR. A. STIERLE, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., January 20, 1890.

GENERAL: I have the honor to submit herewith a report upon the survey of Manokin River, Maryland, made under your direction, and a project for the improvement of the same.

The survey was made during the months of August and September, 1889, and extended from the lower bridge at Princess Anne, Md., to Sandy Point, a total distance of 10½ miles. About 6¼ miles of the upper and narrow portion of the river were located by transit lines: the rest, the wider portion, by triangulation.

The Manokin opens into Tangier Sound, Chesapeake Bay, with a broad, funnel-shaped mouth, 4 miles wide at the lower end, through which a distinct and tolerably straight channel from 9 to 42 feet deep, and about 10 miles long, leads in a northeasterly direction to the river proper above. The latter may be said to begin at a point opposite the junction of two small tributaries, Broad Creek from the south and St. Peter's Creek from the north, where, after a gradual contraction of the mouth, the width between the shores is about three-quarters of a mile. The deep water from the outside extends about 1¼ miles farther up to a point opposite Darby Creek, where the channel is interrupted for a distance of nearly 3 miles by shallow mud flats. These flats end at Sharp's Point.

At Sharp's Point, by a sudden advance of the south shore, the width of the river is reduced from 1,370 feet to 435 feet within a distance of 1,000 feet, and thenceforward remains narrow to the bridge at Princess Anne, a section about 7 miles long. In general, the course of the river is devoid of any very sharp and long bends. Those that do exist apparently do not impede navigation nor retard the flow of the tide to any great degree. The configuration of the bottom is with the exception of one or two points, especially at the confluence of small creeks, not very variable and little distorted by violent actions of currents.

There are three distinct and characteristic sections in the river as regards width, depth, and capacity, the first extending from the outer slope of the mud flats at Darby Creek to Sharp's Point, a distance of about 16,000 feet; the second from Sharp's Point to the junction of King's Creek; and the third from King's Creek to the bridge at Princess Anne, both of the same length, 18,000 feet.

The average depth of the cross-sections in the first section is 2.3 feet, in the second 6.5, and in the third 4 feet. The average width is 2,226,204, and 98 feet, and the mean cross-sections at low water 5,264, 1,329, and 397 square feet in each section in the order in which they are named.

The average of the maximum depths in the channel over the mud flats, which is very indistinct and difficult to trace, is only 4.2 feet. The second section is the deepest, the average depth in the channel being 12.1 feet. A remarkably deep hole was located in this section just above Sharp's Point, which was sounded to a depth of 115 feet and no bottom found. It is the common belief of the fishermen in the neighborhood that this hole is over 125 feet deep. The diameter across the top is reported to be not over 30 feet.

The average depth in the channel of the third or upper section is 6.8 feet, the shoalest portion being at the extreme upper end, between Dashiell's Wharf and the bridge above, where the average depth is 2.6 feet.

The bottom throughout the river is sticky, bluish mud; in only a few of the deeper places hard, fine sand was found. Tidal observations were made from August 9 to September 6 on three gauges, located at Dashiell's Wharf at Princess Anne, at Milligan's Wharf, 6¼ miles below, and at Locust Point Wharf, 2 miles farther down.

The two last-named may be said to be practically located near the upper and lower limits, respectively, of the mud-flats. These observations were valuable only to determine, roughly, the principal phenomena of the local tides, as much difficulty was experienced in enforcing a proper attendance on the part of the observers to their work, especially as to time. It is to be regretted that the funds and time allotted for the survey did not permit the erection of a self-registering tide-gauge at the lowest point of the river as a standard gauge, nor the connection between the different gauges by a line of levels. For the lack of these no accurate data concerning the tide can be given. The deductions that follow, however, were principally determined by empirical rules and are correct for all practical purposes in the present case.

At Locust Point the mean rise and fall of the tide is 2.63 feet. The average duration of flood is five hours and fifty-five minutes, the average duration of ebb six hours and thirty minutes, high water stands on an average for thirty-three minutes, and low water for thirty-five minutes. The mean rise and fall at Milligan's Wharf is 2.60 feet, the average duration of flood is five hours fifty-one and a half minutes, that of the ebb six hours and thirty-three and a half minutes; the average time of high-water stand is thirty-one minutes, of low-water stand thirty-two minutes. Comparing the results obtained at Princess Anne with those above, it appears that the tidal wave receives but little change in its passage through the upper section of the river.

The mean rise and fall at this gauge is 2.11 feet; the average duration of the flood is five hours and forty-eight and a half minutes, and that of the ebb six hours and thirty-six and a half minutes.

The decrease in the rise and fall of about one-half of a foot is entirely due to the narrow width between the shores. The bed in the river, however, offers only a slight resistance, for the duration of the flood at Princess Anne is only three minutes less than at Milligan's, and the duration of the ebb is correspondingly increased. The high-water stand at Princess Anne is on an average of forty-seven minutes' duration, indicating but weak or no current in the upper river towards the last stages of the flood, and the average duration of low-water stand is thirty-seven minutes. The latter period, being so short, shows also the almost total absence of any fresh water inflow from the headwaters of the Manokin, which generally is so small that it has no appreciable effect upon the tide below. The influence of the tide is felt no farther than to a point north of the town, about three-quarters of a mile above the bridge, where the survey commenced.

It remains to record the computed and observed velocities of the tidal wave throughout the river. As stated above, the tidal observations made were too incomplete to give the accurate slope of the water's surface at different stages of the tide and to deduce from that any reliable data as to the velocity of the flood and ebb currrents. The latter, however, are functions of the velocity of the tidal wave, and from a recital of the progress of this wave a relative comparison may be easily inferred. The crest of the tidal wave, or high-water, approaches the mouth of the river from Tangier Sound with an average velocity of 32 feet per second. In passing over the shallow mud flats within the mouth this velocity is considerably reduced and is only 14 feet per second.

After entering the river proper at Sharp's Point and meeting deeper water it increases again to 21 feet and remains so as far as the junction of King's Creek. Between the mouth of King's Creek and the wharf at Princess Anne it is 16 feet per second. These velocities are for mean depths only within the sections named. They vary, of course, slightly, when the depth increases or decreases, and are the smallest at the head of the river. In the same manner the average velocities of the foot of the wave or low water are as follows: At the entrance to the river 31 feet, over the mud flats 11 feet, within the middle or deeper section of the river 19 feet, and within the upper section 14 feet per second. These figures indicate that the progress of the wave is principally retarded at the mud flats and at an increasing ratio towards low water.

Under favorable conditions there would practically be no difficulty to improve this river throughout and make it as deep at the upper end as at the mouth. Such a plan would require mainly the widening and occasional straightening of the upper river and the contraction of the widths and the construction of a channel of proportionate capacity within the broad and shoaler section below. But this would be a costly plan for a river whose commerce is still in embryo; nor is it likely that there will ever be any need for it. The channel in the upper section is ample for the present needs of navigation and requires but little improvement. The mud flats in the lower section, however, are a serious obstruction, the more so by their extent and the prevailing shoal water, and in designing a project for their improvement the fact has been steadily kept in view to make the cost as small as the conditions surrounding it would warrant without sacrificing, however, any of the elements which insure permanency.

The most economical plan of improvement for the time being would be to dredge a channel across the flats of such a depth and width as the present and prospective commerce of the river may require, and to trust to good luck and to the paddle-wheels of passing steamers to keep this channel open. That this would be but a temporary measure has almost invariably been proven at other and similar improvements where the apparent remedy consisted merely in the removal of the effects of unfavorable conditions, and not in the removal of their cause.

These flats are the result of accumulations of many years and form a neutral ground upon which the finer sediment carried in by the flood tide from the sound and brought down from the upper river by the ebb is precipitated at the slack of tide. They are steadily growing in extent and continue thus to be a growing barrier to the flow of the tide, and in this state interchangeably affect the whole river for the worse.

There are two ways of removing this obstruction: first, by a considerable enlargement of the tidal capacity of the upper river by increasing the width between the shores, a plan which can not be entertained on account of its great cost, and, second, by contracting the water-way where the obstruction exists to form a new channel, the latter to be principally made by dredging. The second plan has been used as a basis for the project of improvement herewith submitted, and embraces all that section of the river lying between Back Creek and Sharp's Point. The dimensions of the proposed channel have been determined in the following manner: All the physical characteristics of the whole river were plotted in reference to the mean low-water plane upon a longitudinal profile. Assuming that the mean depths in the river above Sharp's Point are sufficient for a 6-foot low-water navigation, and that the cross-sectional area of the river at Back Creek, the extreme lower end of the survey,

is a measure of the existing tidal capacity below the flats, the curve of the mean depths from above was extended at the same rate of curvature from Sharp's Point to Back Creek and thus the required mean depths over the flats was established. The curves of mean areas having been left undisturbed, the required width for the proposed channel could be readily calculated. The lines of the proposed channel are shown in red on the accompanying map. (Sheet No. 2.)

The amount of material to be removed in this channel if cost was of no consideration is 1,613,926 cubic yards. A large proportion of this quantity can be removed, however, with the assistance of the scouring action of the tide if only a central cut is made, leaving the sides and the center of the cross-section to be removed by the currents. Assuming that the cross-sections will be parabolic in form, which they generally are, and limiting the depth of the cut to the proposed mean depth at each section (the required mean depth at Sharp's Point being 8.9 feet; at Back Creek 13.3 feet), the width at Sharp's Point will be 150 feet, and at Back Creek 235 feet. The amount of material to be removed by dredging in this cut will be 1,095,111 cubic yards, leaving about 500,000 cubic yards to be removed by the currents. The removal of the amount to be dredged is, from an engineering stand-point, absolutely necessary to make the improvement permanent. To afford a temporary relief a much smaller channel would answer the requirements of navigation. A width of 50 feet and a depth of 6 feet at mean low water would be sufficient in that case, and the amount of material to be dredged would be 77,000 cubic yards.

Such a channel might remain open for several years, but the forces at work would inevitably tend to restore the former condition. The estimate for a temporary channel is added below. It is necessary that the new channel should be protected and secured in a measure, especially at the concave sides, though it is possible that the character of the material of which the bottom consists may to a certain extent prevent any bad effects upon the sides of the cut by the currents. At the most exposed points a line of brush mattresses about 2 feet in thickness should be laid parallel to and along the edge of the channel as a foundation for an embankment, which is to be made entirely with the material taken out of the cut. These training banks, as they may be called, should not be carried to a higher level than that of low water, and should be connected at their upper end with the shore, leaving the portions of the river on each side of the channel to form tidal basins for the benefit of the river below. The lines of the proposed banks are indicated on the map. If the channel could be carried to completion in a comparatively short period, it is possible that the mere formation of these banks without mattresses along the lines indicated would suffice to confine the currents until the necessary channel depth is established.

I consider the opening of the channel and the construction of the bank along its northern edge in the middle portion of the flats from Goose Creek to Locust Point the most important in the order of execution, and for this bank only an estimate for mattresses is included in the project. Much may be learned after the work (if sanctioned by Congress) has made some progress and an opportunity is given to notice the effects and the tendencies of the currents in the section under consideration. The great benefit that would accrue to the whole county adjoining the Manokin River by the removal of this formidable obstacle to navigation has been fully pointed out in the report of the preliminary examination, in which full commercial statistics are given, to which I would respectfully refer.

A steamer 120 feet long was placed on the river in May last, to carry freight and passengers to Deal's Island in Chesapeake Bay, where connection is made with the steamers of the Maryland Steamboat Company to and from Baltimore. This steamer is often delayed at the flats until the tide has risen sufficiently to pass over. It is stated that the amount of freight carried on several occasions during the past summer exceeded that shipped from the Wicomico River below Salisbury, Md. Several new wharves have been built recently; one by the county at Locust Point is now being constructed, and will be 400 feet long and is to be connected with the mainland by a new road across the marsh about a mile in length.

ESTIMATE.

First project: For a permanent channel across the mud flats between Sharp's Point and Locust Point:	
(*a*) Dredging 1,095,108 cubic yards, at 25 cents	$273,777
(*b*) Brush mattresses for training-dike from Goose Creek down, 5,700 linear feet, 32 feet wide and 2 feet thick, 13,511 cubic yards, at $1	13,511
Total	287,288
Second project: Dredging a temporary channel 50 feet wide and 6 feet deep at mean low water between the same points:	
77,000 cubic yards, at 20 cents	15,400

Very respectfully, your obedient servant,

A. STIERLE,
Assistant Engineer.

General WM. F. SMITH, *United States Agent.*

H 21.

PRELIMINARY EXAMINATION OF ELK RIVER, MARYLAND.

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., November 8, 1888.

GENERAL: In compliance with the requirements of section 14 of the river and harbor act of August 11, 1888, and the instructions contained in the letter from the office of the Chief of Engineers of September 29, 1888, I have the honor to submit the following report upon the preliminary examination of Elk River, Maryland, made under my direction by Mr. A. Stierle, assistant engineer.

For the reasons and facts given in the report of Mr. Stierle, a copy of which is herewith inclosed, I consider Elk River worthy of improvement, by giving additional width and depth to the channel, and I recommend a survey of it. It is more than probable that an increased tidal prism would give greater permanence to the depth of the channel near the head of navigation.

A rough estimate of the cost of the desired improvement is $20,000.

The least amount required to make the survey, with report and estimate of cost of improvement, is $200.

Very respectfully, your obedient servant,

WM. F. SMITH,
United States Agent.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. A. STIERLE, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., November 8, 1888.

SIR: In compliance with your instructions, I have the honor to submit the following report upon the preliminary examination of Elk River, Maryland.

Elk River is one of the extreme northern tributaries of Chesapeake Bay. It rises in Chester County, Pa., and has a total length of about 35 miles. The river has for its tributaries, Little Elk Creek on the west side, and on the east side Perch Creek, Back Creek (which is the outlet of the Delaware and Chesapeake Canal), Bohemia River, Cabin John's Creek, and Pond Creek, besides numerous smaller branches which drain the adjacent country. The head of navigation is now at the town of Elkton, 16 miles above the mouth of the river. During the Revolutionary period, until about 1812, it extended farther up the river and later the main landing was located near the junction of Elk and Little Elk rivers, a short distance below the town.

The present depth of water appears to be sufficient for all practical purposes in the navigable portion of the river as far up as Cedar Point, about 3 miles below Elkton. A bar exists at that point with a reported depth of only 6 feet over it at mean low water. From that point to the bridge at Elkton the depth gradually diminishes, it is said, to only 4 feet at the latter place. The width of the river within the shoal section is between 130 and 350 feet, and the average rise and fall of the tide is about 2½ feet.

The navigation interest requires, and the present commerce centering at Elkton demands, a clear and unobstructed channel 8 feet deep at mean low tide to the wharves of this town.

This river has been under improvement by the United States Government at stated periods from the year 1873 to 1884, inclusive, when the original project, made in 1873, for its improvement was completed. This project embraced the dredging of a channel 6 feet deep at mean low water and either 50 or 70 feet wide from Cedar Point to the bridge at Elkton, and also in the Little Elk River, as high as Bennett's Wharf, and the construction of about 3,300 feet of dike within the same section. At the date of the completion of the project there existed a channel 80 feet wide and 7 feet deep at mean low water through the bar at Cedar Point, and from thence to the bridge

at Elkton a channel 70 feet wide and 7 feet deep at mean low tide. About 900 feet of dyke had been constructed; but it appears that no improvements have been made in Little Elk River as originally contemplated.

The shoaling of the channel at Cedar Point and near the bridge at Elkton, above referred to, which has taken place in so short a time after operations for its improvement have ceased, would indicate that some other plan than dredging may be necessary to place the maintenance of the channel upon a more permanent basis. Training-dikes may be of better service at the former point and cheaper in the end. At Elkton Bridge that neutral region evidently exists which may be found in every river partly under tidal and partly under fresh-water influences, where the tide and the fresh water meet and the slackened currents make the largest deposits. If this assumption as to the last-named locality is correct, there remains no alternative but annual dredging. The trade on the upper section of Elk River has increased to a large extent since the river has been improved, as is shown by the following extract of a letter received from Mr. W. H. Mackall, vice-president of the Scott Fertilizer Company, of Elkton, Md.:

"Prior to the Government work on the Elk River there was no trade by water from this point, though there was a little business done from a point 1 mile below here; since that time our business has greatly increased. Mr. Singerly, of the Philadelphia Record, has built a large pulp-mill here on the river and a paper-mill a few miles north of the town. The paper-mills and our works give employment to about 250 to 300 men. The population of the town has increased from 1,900 by the last census to 2,500.

We have received by water during the current year 2,500 tons of coal and 3,000 tons of fertilizer stock.

We have shipped by water 2,500 tons of manufactured fertilizers.

The number of vessels discharged at the pulp-mill wharves during 1888 to October 27 was 132, of from 40 to 100 tons custom-house register, and carrying from 35 to 165 cords of popular wood each. Their contracts for wood amounted to more than 9,000 cords for the past season, and they use between 7,000 and 8,000 cords per year. We buy phosphate rock in Charleston, S. C., and have to reload it into barges at Baltimore, which is quite expensive, and would not be at all necessary if a small appropriation was expended on our river.

The agricultural interests in this section have also been greatly benefited by the money already expended on this river, as the water competition has reduced the freight on grain from 10 cents per 100 pounds to 3½ cents from Elkton to Baltimore, and has lowered the rates from other points in the country in proportion."

It would appear proper to prevent any deterioration of the commerce of the river after it has received such a stimulus. A survey of the region lately under improvement and to extend about one-half of a mile above the county bridge, the present head of navigation, to include the collection of data as to freshets, character of the material causing shoaling, and tidal observations, is recommended. Its cost would be about $200

Very respectfully, your obedient servant,

A. STIERLE,
Assistant Engineer.

General WM. F. SMITH,
United States Agent.

SURVEY OF ELK RIVER, MARYLAND.

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., January 22, 1890.

GENERAL: In compliance with the instructions contained in the letter of June 18, 1889, from the office of the Chief of Engineers, and the requirements of the river and harbor act of August 11, 1888, I have the honor to submit the following report upon the survey of Elk River, Maryland, made under my direction in October, 1889.

The original project for the improvement of this river was completed in 1884. The benefit of the improvement has in respect to the width of the channel been overcome in six years. As only temporary relief can be looked for in such a stream, except at inordinate cost, and as the filling in seems to be in width almost entirely, I recommend for a new project the widening of the channel to 100 feet, with a depth of 7 feet at mean low water.

This would require the removal of 120,000 cubic yards of material, which, at 20 cents per cubic yard, would be $24,000.

A copy of the report of the assistant engineer is herewith inclosed.

A tracing of the map* of the survey is sent by mail to-day in a separate package.

Very respectfully, your obedient servant,

WM. F. SMITH,
United States Agent.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. A. STIERLE, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., January 21, 1890.

GENERAL: I have the honor to submit herewith a report upon the survey of Elk River, Maryland, and a project for the improvement of the same.

This river has been under improvement at various times by the General Government, between the years 1873 and 1884. The total amount expended was $31,500. In the latter year the original project was completed. A channel existed after the close of operations 80 feet in width and 7 feet deep at mean low water across the bar below the mouth of Little Elk River, and from that point to the bridge at Elkton, a distance of 5,900 feet, a channel 70 feet wide and 7 feet deep at mean low water.

The survey was made during the month of October, 1889, and extended from opposite the club-house below Cedar Point to the new iron bridge above the town of Elkton. This bridge is 8,200 feet above the lower bridge, where all the surveys and improvements formerly made ended. It was thought necessary to extend the survey thus far in order to get at the causes of the constant filling in below. The survey shows that the channel dredged in 1884 has maintained itself very well below the mouth of Little Elk River. Above it has narrowed considerably, being in some places not more than 25 feet wide; the trough of the channel, however, indicates comparatively little shoaling. Most of the filling-in has taken place just below the bridge and on the south side of the channel.

Tidal influence is felt to a point 4,800 feet above this bridge. Above that the river is fresh, discharging at times considerable water, and has a slope of 1 in 210 feet from the mill-dam just above the upper bridge to the junction with the mean tidal level below. The bed is very sinuous and consists mainly of large stones, coarse gravel, and sand. The finer material is generally swept by the freshets into the tidal portion of the river below. These freshets are sometimes very heavy and rise suddenly and with great velocity. By referring to the profile on the map it will be seen that the material brought down from the river must necessarily settle at the junction of the slopes or a certain distance farther down.

There are three plans by which the filling-in, from this cause, of the harbor and channel below can be avoided. First, by building cross-dams at different suitable points in the valley above to reduce the slope and to form catch-basins for the material carried by the freshets; second, by widening and deepening the river immediately above the lower bridge to increase the general tidal capacity; and, third, by redredging the present channel periodically. The first is a costly but thoroughly effectual plan. The second plan is one which has several special features to recommend it. It would afford additional water-front in the heart of the town, making the shores available for the construction of wharves and industrial buildings. Besides that, it would be a beginning of regulating that portion of the river flowing around the south side of Elkton. For if this portion was wholly or only partially confined within properly regulated shores, instead of being left to itself as at present, there can be no doubt that the material brought down from the upper river would be carried much farther down into the estuary of Elk River and thence farther out by the tide.

The third plan is the one heretofore followed. It is a temporary relief-plan, performed at stated periods, and, though requiring small amounts for its execution, it is possible that if the commerce of Elkton continues to increase it may have to be abandoned ultimately for a more rational one.

Two or three heavy freshets occurring in quick succession may at any moment fill the channel to such an extent as to destroy entirely its usefulness for the larger class

---

*Omitted.

of vessels. These vessels sailing to and from the wharves at Elkton are of deep draught and their tonnage individually is large, but the present width and depth of the channel is barely sufficient for their movements.

The commercial statistics with regard to this river are given in the report of the preliminary examination, to which I would respectfully refer.

The project recommended is for a channel 100 feet wide and 8 feet deep at mean low water, beginning near the club-house below Cedar Point and extending to the bridge at the upper end of the wharves; the section at the wharves as far as built to be widened to the same depth and to the full width between the present bulkheads.

Estimate:

Dredging 120,000 cubic yards of material, at 20 cents..... $24,000

Very respectfully, your obedient servant,

A. STIERLE,
Assistant Engineer.

General WM. F. SMITH,
United States Agent.

H 22.

PRELIMINARY EXAMINATION OF ONANCOCK HARBOR, VIRGINIA.

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., December 5, 1888.

GENERAL: In compliance with the requirements of section 14 of the river and harbor act of August 11, 1888, and the instructions contained in the letter of September 29, 1888, from the Office of the Chief of Engineers, I have the honor to submit the following report upon the preliminary examination of Onancock Harbor, Virginia, made under my direction by Mr. A. Stierle, assistant engineer, and a copy of his report, with full information, is herewith inclosed.

As Onancock Harbor, or more properly speaking Onancock River, has been the subject of former surveys, reports, and improvement, a resurvey is recommended, the stream being deemed worthy of improvement.

The estimated cost of the improvement of the bar at the mouth and the shoals in the river is $15,000.

The least amount required to make the survey and report, with estimate of cost of improvement, is $450.

Very respectfully, your obedient servant,

WM. F. SMITH,
United States Agent.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. A. STIERLE, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., December 5, 1888.

GENERAL: In accordance with your instructions I have the honor to submit the following report upon the preliminary examination of Onancock Harbor, Virginia:

The last river and harbor act provides for an examination of Onancock Harbor, Virginia. As there is no sheet of water known under that name, and as the Onancock River near the town of Onancock can hardly be called a harbor, since it is only one of several landing places, the examination was made to include the whole of Onancock River.

Onancock River is a tributary of the Chesapeake Bay, and lies within the county of Accomac, Eastern Shore of Virginia. Its course is generally westwardly. The channel in the river is narrow and somewhat tortuous, with one very abrupt turn near Finney's Wharf, and two troublesome obstructions, one at Wise's Point and the other called

e Middle Ground. The channel across the bar at the mouth is straight and leads a west-northwesterly direction into the bay at the junction of Pocomoke Sound th the latter. The depth over the bar is stated to be only 5 and 5½ feet at mean low ater for a total and continuous distance of about 1,200 feet, the bottom being fine mpact sand. The inner edge of this bar lies and the channel from the river closes at point nearly three-fourths of a mile from the shore. Inside the river are several arrow and shoal points with a depth of water of not over 7 feet at mean low tide. e width between the banks increases from about 300 feet near Onancock wharves about 2,400 feet at the mouth; these banks consist of light fine sand, easily transorted by rains and tide. The total length of the navigable part of the river is about miles; the rise and fall of the tide about 2 feet.

The main obstruction to the present navigation is said to be at the bar. This ver was surveyed in 1878 by Capt. Charles B. Phillips, Corps of Engineers, U. S. rmy, and a project submitted and approved for an 8-foot channel, 300 feet wide ross the bar, and 100 feet wide through the mud-flats near the town of Onancock, an estimated cost of $10,000. Two appropriations were subsequently made for the improvement of the river, one of $3,000 in 1879, and one of $5,000 in 1880. Under e first a channel 100 feet wide and of the originally proposed depth, 8 feet, was edged across the bar at the mouth; about 12,000 cubic yards of material were reoved. The second and last appropriation was expended in making a channel 7 et deep and 100 feet wide near and above Wise's Point, and in dredging near the eam-boat wharf and up to Mile's saw-mill wharf, near Onancock, including the nstruction of a large turning-basin, all to a depth of 7 feet at mean low water. e total amount excavated was 20,297 cubic yards.

The localities dredged within the river have maintained their depth fairly well. the bar the dredge channel has filled up again and is only about 50 feet wide and om 5 to 5½ feet deep. But it was not expected that this channel would remain open, Colonel Craighill, Corps of Engineers, who had charge of the improvement, in s report for 1880 says, "If it does, it will be a remarkable case."

The improvements were of great benefit to the shipping on the Onancock. A line steamers has since been established and maintained with Baltimore which makes mi-weekly trips. The number of sailing vessels has also increased. There are two nding places on the river, one at Onancock, and the other at Finney's Wharf. The gregate amount of shipping from both is very large, consisting mainly of potatoes e staple product of Accomac County.

Captain Hopkins, of Onancock, states that during the past year there was shipped om the river about 100,000 bushels of sweet and white potatoes; fruit and berries the value of $20,000, and vegetables and garden truck $25,000.

The imports consisted of 300 tons of guano and phosphates; 2,000 tons of coal; 0,000 shingles; 100,000 feet of lumber, cypress and cedar; 200,000 bricks, and genal merchandise to the value of $300,000. About 12 sailing vessels, with an average pacity of 50 tons, are owned by parties living along the river.

The impending closure of the channel across the bar will be a severe blow to the mmerce of the river, unless some remedy is applied to prevent it.

The commercial interests involved ask for a channel 8 feet deep at mean low water d 200 feet wide at the entrance. No desire has been expressed, so far as known, r improvements within the river proper, although they are needed. It is estimated at the dredging of the channel across the bar with the dimensions indicated would st about $9,000.

To compare the present conditions of the river with those elicited by previous surys and to suggest, if possible, some other means for maintaining a free and unobructed entrance, a survey of the whole river, to include a series of current observaons at the mouth, is recommended.

It is estimated that the cost of such a survey would not exceed $450.

Very respectfully, your obedient servant,

A. STIERLE,
Assistant Engineer.

General Wm. F. SMITH,
United States Agent.

SURVEY OF ONANCOCK HARBOR, VIRGINIA.

UNITED STATES ENGINEER'S OFFICE,
Wilmington, Del., December 24, 1889.

GENERAL: In compliance with the instructions contained in the letr of April 6, 1889, from the office of the Chief of Engineers, and the quirements of the river and act of August 11, 1888, I have the honor

to submit the following report upon the survey of Onancock Harbor, Virginia, made under my direction during October, 1889.

The survey seems to show that the only way to keep the channel open across the bar is by dredging, done as often as necessary.

The estimate for the amount needed at first is for the removal of 62,555 cubic yards of material, which, at 20 cents per cubic yard, amounts to $12,511.

A copy of the report of the assistant engineer is herewith inclosed.

A tracing* of the map of the survey is sent by mail to-day in a separate package.

Very respectfully, your obedient servant,

WM. F. SMITH,
United States Agent.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. A. STIERLE, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., December 23, 1889.

SIR: I have the honor to submit herewith a report upon the survey of Onancock River, Virginia, and a project for the improvement of the same.

The survey was made during the month of October last and embraced principally an examination of the obstructions existing at the mouth. A series of cross-line soundings, commencing at the head of the river, at Onancock, was run throughout the length of the river as far as the mouth, to ascertain the condition of the channel generally and in particular that portion dredged nine years ago. The survey shows little change in the channel since that time, except at a point just below the wharves at Onancock, where a slight encroachment from the north shore has taken place, reducing its former width considerably. With the exception of one or two sharp turns farther down, that might be improved by widening them on the convex side of the channel, the navigation of the channel throughout the river by vessels drawing 8 feet is unimpeded.

The shore-line at the mouth was carefully determined by triangulation, and soundings were taken from the shore to deep water in the bay, the lines extending from three-quarters of a mile above to about one-half of a mile below the mouth. A tracing of this portion of the survey is herewith submitted. The channel, which was dredged across the bar in 1880 to a depth of 8 feet at mean low water and 100 feet in width, has filled up again, as was predicted at the time. The present depth over the bar is 5½ feet at mean low tide, nearly the same depth as prevailed there before improvements commenced. The width of channel over the bar with this minimum depth is about 150 feet. The distance from the nearest point on shore to the bar is 4,400 feet.

About 1,800 feet from the shore, and before arriving at the channel proper over the bar, vessels going out of the river experience great difficulty in passing through a very narrow portion of the channel at a point called the "Middle Ground." The depth in the channel is 8 feet and sufficient for navigation, but the width is so much reduced, being only 40 feet, that even steamers pass through with great caution. This portion of the channel was from 125 to 250 feet wide in 1880, and had a minimum depth of 10 feet at mean low water.

The question of maintaining an open channel of the required depth, 8 feet, across the bar by artificial structures is one not of cost alone; the surrounding physical conditions are such that it appears doubtful if such works were built whether the result would meet the expectations. It would be a very difficult problem to deal with and a very costly one, the execution of which is not justified by the amount of commerce involved.

Periodical dredging is evidently the least expensive way to keep the channel open; and, judging from past experiences, if the channel should be made of ample width at one time, the increase in cross-section of channel may cause a more concentrated flow of the currents at that point and a proper depth may obtain for a long time.

It is proposed in the project herewith to make the channel across the outer bar 300

---

* Omitted.

feet wide, that at the inner bar or Middle Ground 200 feet in width, both to be dredged to a depth of 8 feet at mean low water. The latter section is projected south of the Middle Ground, instead of following the present narrow channel north of it, as the latter evidently is being rapidly closed by the littoral drift coming down the north shore.

It is desirable that if any appropriation is made by Congress to continue the improvement of this river it should be made sufficiently large to carry the improvements herein indicated to completion at one time.

For information in reference to the commerce of the river, I would respectfully refer to the statistics given in the preliminary report.

ESTIMATE.

Dredging a channel 300 feet wide and 8 feet deep at the outer bar..cubic yards..	40,000
Dredging a channel 200 feet wide and 8 feet deep at the inner bar....do....	22,555
Total	62,555
62,555 cubic yards, at 20 cents	$12,511

Very respectfully, your obedient servant,

A. STIERLE,
Assistant Engineer.

General WM. F. SMITH,
United States Agent.

H 23.

PRELIMINARY EXAMINATION OF HARBOR OF CAPE CHARLES CITY AND APPROACHES BY CHEUTON INLET, VIRGINIA.

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., October 24, 1888.

GENERAL: In compliance with the requirements of section 14 of the river and harbor act of August 11, 1888, and the instructions contained in the letter from the office of the Chief of Engineers of September 29, 1888, I have the honor to submit the following report upon the preliminary examination of the harbor of Cape Charles City and approaches by Cheuton Inlet, made under my direction by Mr. A. Stierle, assistant engineer.

How far the entrance to a harbor which is entirely the work of private enterprise and admission to which is refused to general commerce is "worthy of improvement" would seem to be a new question. In a somewhat similar case in the State of Delaware an appropriation was not expended until all claim to levy tolls was abandoned. Under the only precedent of which I have knowledge, therefore, the improvement is not recommended until the harbor is made free to all shipping which can and may desire to enter it.

A copy of the report of the assistant engineer with detailed information is herewith inclosed.

The cost of the desired improvement, which consists in the removal, by dredging, of a portion of the eastern bank of the channel near the entrance to the harbor, would be about $25,000.

Very respectfully, your obedient servant,

WM. F. SMITH,
United States Agent.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. A. STIERLE, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., October 22, 1888.

SIR: In compliance with your instructions of October 4, 1888, I have the honor to submit the following report upon the preliminary examination of the harbor of Cape Charles City and approaches by Cheuton Inlet.

There is no inlet leading to this harbor that is called "Cheuton Inlet." An examination of all available charts and inquiries made at Cape Charles and vicinity failed to discover any inlet of that name at that point along the Atlantic coast and the shores of the Chesapeake Bay. It is presumed that this name, as given in the last river and harbor act, is a misprint, and was intended for Cherrystone Inlet, which is the only inlet leading towards the harbor of Cape Charles City.

Cape Charles City is situated in Northampton County, Va., on the Chesapeake Bay, and near the extreme promontory formed by the eastern shore of Virginia, and is about 12 miles north of Cape Charles Light. It is a town of quite recent origin, having been founded about six years ago by the New York, Philadelphia and Norfolk Railroad Company, and has at present about 800 inhabitants. The company, which was then extending its tracks down the peninsula, selected this point as a terminus from which the transfer of its freight and passengers by water could be made to Norfolk, Va., upon the opposite shore of the bay. The place then had no particular natural advantages for the construction of a large harbor.

About one-quarter of a mile distant and parallel with the beach lay the channel leading toward Cherrystone Inlet, 3 miles to the north of it. The 12-foot curve in this channel closed not far above this point, but it appeared again here and there farther up. This 12-foot curve evidently formed the basis from which the railroad company started the extensive improvements which were subsequently made.

A straight cut between 10 and 12 feet deep, 200 feet wide, and 1,500 feet long was made from the 12-foot depth in the channel at right angles to and continued through the beach. A fresh-water pond close behind the beach was the objective point of the cut made from the outside. The greater portion of this pond was then dredged out and deepened to 11 feet, below low water of the bay, and thus an artificial harbor was made of rectangular shape and with an area of about 11 acres. Millions of cubic yards of material were removed to make these improvements. The necessary accessories to a harbor of such magnitude, such as bulkheads, wharves, freight, and passenger depots, offices, landing slips, etc., were subsequently constructed by the railroad company.

It appears that on account of the rather narrow width (500 feet) of the channel opposite to the entrance of the harbor the barges and large floats of the railroad company are often driven upon the eastern bank of the channel in trying to make harbor during strong westerly and northwesterly winds. The approaches to the entrance need rounding off on the shore side of the channel, the change in direction of the latter being too sudden for the limited space in which to go about. This seems to be the only improvement desired by the railroad company. There is, however, a strong interest among the inhabitants of the city in the erection of a public landing pier and an extension of the outer channel thereto. Such an addition to the existing shipping facilities would greatly stimulate local commerce.

At prevent no vessels are allowed to enter the harbor with the exception of those carrying freight intended for shipment by rail.

STATISTICS.

Statement showing number of tug and barge trips to and from Cape Charles Harbor, number of cars transported by said barges, and amount of freight in the cars transported by the barges.

Years.	Trips.			Cars transported.			Freight transported.
	To.	From.	Total.	Loaded.	Empty.	Total.	
							Tons.
First six months, 1886	253	253	506	4,938	1,667	6,605	36,341
Second six months, 1886	212	212	424	4,652	790	5,442	37,377
First six months, 1887	395	396	791	7,688	1,837	9,525	67,351
Second six months, 1887	349	348	697	7,917	1,048	8,965	65,885
First six months, 1888	430	430	860	9,931	1,305	11,236	93,511
Total	1,639	1,639	3,278	35,126	6,647	41,773	300,465

Statement showing number of trips by steamers Cape Charles and Old Point Comfort and amount of freight and passengers transported by them.

Years.	Trips to and from harbor.	Freight.	Passengers.
		Tons.	
First six months, 1886	650	4,873	17,060
Second six months, 1886	428	5,032	14,729
First six months, 1887	608	9,068	16,523
Second six months, 1887	366	8,870	15,385
First six months, 1888	487	12,590	16,757
Total	2,541	40,452	80,394

Statement showing number of sailing vessels and number of packages brought by same into Cape Charles Harbor.

Years.	Packages.	Vessels.
First six months, 1886	19,076	127
Second six month, 1886	33,677	225
First six months, 1887	29,538	199
Second six months, 1887	38,976	259
First six months, 1888	34,766	230
Total	156,028	1,040

The removal by dredging of a portion of the eastern bank of the channel near the entrance to the harbor is roughly estimated to cost about $25,000. If the wants of the citizens are taken into consideration, and a channel 100 feet wide is dredged from the outer channel to low-water mark at the foot of Mason street, the cost will be increased by $2,800.

Very respectfully, your obedient servant,

A. STIERLE,
Assistant Engineer.

Gen. WM. F. SMITH,
United States Agent.

SUPPLEMENTARY REPORT.

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., February 11, 1889.

GENERAL: In compliance with the first indorsement, dated January 17, 1889, on a letter to the Chief of Engineers from the Hon. T. H. Bayley Browne, of January 14, 1889, in relation to report of the examination of the harbor of Cape Charles City and approaches, submitted by me October 24, 1888, I have the honor to state that the assistant engineer was directed to again visit the locality and make a further examination and obtain additional information. I herewith inclose a copy of his report, which appears to cover the intent of the requirements of the act of August 11, 1888.

It would appear that the harbor is open for vessels in bad weather or to land cargoes. I therefore recommend a survey of the harbor and approaches.

The least amount required to make the survey with report and estimate of cost of improvement is $1,500. The approximate estimate of the assistant engineer for the cost of the desired improvement is $155,100.

Very respectfully, your obedient servant,

WM. F. SMITH,
United States Agent.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. A. STIERLE, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., February 5, 1889.

SIR: In compliance with your orders to proceed to Cape Charles, Va., to obtain additional information in regard to certain obstructions said to exist in the harbor of Cape Charles and approaches thereto which were not reported upon in the report upon the preliminary examination submitted October 24, 1888, and to which the Hon. Thomas H. Bayley Browne has called the attention of the Chief of Engineers, U. S. Army, in a letter dated Washington, D. C., January 14, 1889, I have the honor to make the following report:

At the time of my first visit to Cape Charles there was no one present higher in authority than a subordinate officer of the railroad company, who gave me all the desired information to the best of his knowledge, I believe. This time I had the pleasure of meeting Mr. H. W. Dunne, the superintendent of the New York, Philadelphia and Norfolk Railroad, whose assistance enabled me to arrive at an intelligent comprehension of the desired improvements.

According to a copy of memoranda which Mr. Dunne handed to me the obstructions and improvements embrace—

First. The bar of Cherrystone Inlet.

Second. The approaches to the harbor of the channel to the slip, widening the channel at the mouth of the slip on the northwest.

Third. Cutting off the back of the channel on the southeast side at the mouth of the slip.

Fourth. The erection of permanent works to make the entrance to the harbor; and

Fifth. The improvements to the harbor itself.

Cherrystone Inlet is a channel about 8 miles long from its head at Cherrystone Wharf to its junction with the North Channel of the entrance of Chesapeake Bay. Its course is nearly due south, and runs at a distance of from one-third to two-thirds of a mile parallel with the shore. The average depth throughout its length and following the deepest portions of the channel is about 18 feet. About 4½ miles above the junction with the main channel of the bay the entrance to Cape Charles Harbor opens into the inlet from the east. Up to this point the average depth of the inlet is 22 feet, the average width between the 12-foot curves about 3,400 feet. Above the entrance to Cape Charles Harbor the average depth in the inlet decreases to 15 feet, the average width between the 12-foot curves to 200 feet.

The inlet is bordered on the east side by the main shore, on the west by a shoal jutting out from and connected with the mainland north of Cherrystone Wharf. The lower point of this shoal is called Old Plantation Flats. The least depth of water over this shoal is 2 feet, the maximum depth nearly 16 feet. At the point where this greatest depth prevails, just north of the Old Plantation Flats, the large boats and barges of the railroad company cross the shoal on their regular trips to and from Norfolk on the other side of the bay. This more direct course is taken in preference to entering the inlet at the lower end, on account of the shorter distance and to avoid the dangers of grounding when strong westerly winds are blowing and tides are low. In crossing the shoal the steamers often touch bottom, and it is desired that a channel should be dredged at this point about 100 feet wide and fully 16 feet deep at mean low water. It is doubtful whether such a cut, which would to a certain degree cross the prevailing currents diagonally, would remain open without the aid of the deflecting jetties or revetment-walls thrown out from the main shore, particularly since the average depth of cutting to the required depth will not be very great.

A further obstruction to the safe navigation of the approaches to Cape Charles Harbor is said to exist near the black buoy south of Cherrystone light-house. The channel here is so narrow that vessels experience great difficulty in passing through it safely during unfavorable weather. It is desired that one of the projecting points on the west bank be cut off about 200 feet to a depth of 16 feet.

The "cutting off the back of the channel on the southeast side at the mouth of the slip," one of the desired improvements enumerated above, has been described fully in the report previously submitted. In addition to this, it is desired that the channel on the northeast side at the mouth of the slip should be widened in a similar manner, to facilitate navigation at that point.

Another of the improvements called for is the erection of permanent works inclosing the entrance to the harbor. This was attempted, in a manner, at the time the harbor was constructed, by two rows of bulkheads and closely-driven piles, about 200 feet apart, and projecting from the shore for a distance of 1,500 feet, slightly curving to the southward at the outer end. A large number of these piles have been broken off at various times by vessels running into them in entering. Barring the frailty of such a structure, works of that character, unless constructed of creosoted material, must eventually succumb to the ravages of the teredo. There is undoubtedly a ne-

cessity for the erection of permanent works to facilitate the entering of vessels, as well as to allow a more economical maintenance of the required depth by dredging, which will always be necessary, as there is no back or ebb current of any duration or strength to prevent shoaling. These inclosures would constitute the entrance, a mere slip extending from deep water in the channel to the harbor, which itself is only a tidal basin. The cheapest and more durable construction for this purpose would be *pierres perdues* jetties on either side, extending to deep water, supplemented, perhaps, by a detached short breakwater upon Cherrystone Shoal, on the west side of the inlet, and opposite to the entrance of the harbor. It is probable that the direction of the whole entrance, or at least the outer end of it, can be changed to more advantage.

The improvements referred to in the memoranda is desired "to the harbor itself" are supposed to comprise mainly an increase in the present depth. The harbor was originally dredged to a depth of about 12 feet at mean low water; since then it has shoaled again, to what extent could not be accurately ascertained; it was estimated, however, by one person at the rate of about 6 inches a year. The bottom consists of soft mud mixed with fine sand. The depth needed is 14 feet.

A proper treatment of the obstructions and improvements above enumerated requires considerable study, and the estimates given herewith may be considerably modified after a survey of the locality has been made and accurate data are obtained, particularly as to currents and the tendency to shoal.

The cost of the improvements desired is roughly estimated as follows:

1. Permanent works of construction, 32,000 cubic yards of stone in place, $3 per yard	$96,000
2. Dredging 180,000 cubic yards, 25 cents per cubic yard	45,000
	141,000
Add 10 per cent. for contingencies	14,100
Total	155,100

Upon further inquiry I have been informed by reliable parties that notwithstanding the fact that the railroad company owns and exercises control over the harbor, they in no case refuse admittance to any vessel that may seek shelter in stress of weather, or that has the intention of communicating with the shore, or to anchor whilst waiting for orders. Since its existence the harbor has been much used by tugboats and the smaller class of sailing vessels trading up and down the bay, and has in this respect become well known as a harbor of refuge. If any freight is landed not consigned to the railroad company, which I am told is often the case, a small wharfage is charged; a right which the company obviously claims to possess.

If a survey is recommended, I estimate its cost to be about $1,500.

Very respectfully, your obedient servant,

A. STIERLE,
Assistant Engineer.

General W. F. SMITH,
United States Agent.

SURVEY OF HARBOR OF CAPE CHARLES CITY AND APPROACHES BY CHEUTON INLET, VIRGINIA.

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., November 21, 1889.

GENERAL: In compliance with the instructions contained in the letter of July 1, 1889, from the office of the Chief of Engineers, I have the honor to transmit herewith a copy of the report of the survey of the harbor of Cape Charles City and approaches by Cheuton Inlet, Virginia, made under my direction by Mr. A. Stierle, assistant engineer, with estimates for an improvement based upon the supposed needs of commerce passing in and out of the harbor.

The survey was provided for in the river and harbor act of August 11, 1888.

Mr. Stierle's report is exhaustive and seems to leave no room for further discussion. The estimates are indorsed as proper under the project submitted, which appears to be the simplest one possible.

A tracing * of a map of the survey is transmitted by mail in a separate package.

Very respectfully, your obedient servant,

WM. F. SMITH,
United States Agent.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. A. STIERLE, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., November 19, 1889.

GENERAL: I have the honor to submit the following report upon the survey of the harbor at Cape Charles, Virginia, and approaches thereto by "Cheuton Inlet," made under your direction, and the following project for its improvement.

The survey was made during the month of September, 1889. The prevalence of very stormy weather somewhat delayed the progress of the work, but afforded a good opportunity to observe the effects of winds and waves on this part of the coast.

Cape Charles Harbor is an artificial one, and of quite recent date. It forms the peninsula terminus of the New York, Philadelphia and Norfolk Railroad, having been completed simultaneously with the road, and is situated in Northampton County, on the Chesapeake Bay, about 12 miles north of Cape Charles, the southernmost point of the peninsula formed by the State of Delaware and the Eastern Shores of Maryland and Virginia.

The harbor is accessible for vessels of deep draught only from a southerly direction by way of Cherrystone Inlet, which throughout runs nearly parallel with the shore and opens about 4½ miles below into the main channel of Chesapeake Bay. The entire western limit of Cherrystone Inlet is flanked by an extensive and very flat shoal more than a mile in width. About 2 miles south of the harbor is a depression across this shoal. All vessels drawing less than 14 feet of water can sail across here at any stage of the tide. This course is taken by all the boats of the railroad company on their voyage to and from Norfolk on the other side of the bay.

The survey extended from Old Plantation Light, south of this channel, across the bar, to Westcott's Point, a projection of the main land north of Cherrystone Creek, and as near as was practicable to the outer edge of Cherrystone Bar.

In sailing on a northeast course from the bay, a vessel approaching the harbor of Cape Charles encounters the bar of Cherrystone Inlet about two miles from shore. She crosses the bar for a distance of one and three-quarter miles upon a course fixed by two small range-lights, which are maintained by the railroad company, until the channel of Cherrystone inlet is reached. The least depth of water at common low tide on this range is 14½ feet; the width of the channel is ample, notwithstanding the diagonal direction of the sailing course. About one quarter of a mile from shore the course is changed to east by north, running almost parallel with the former and following the channel of Cherrystone Inlet up to the channel leading to the harbor. The minimum depth of water in this section is 11 feet; the channel-width gradually decreases to 600 feet, the extensive flats along the shore end of Cherrystone Bar closing in rapidly on either side.

The entrance to the harbor opens from the main channel in an easterly direction. It is here where in stormy weather the long tows of barges meet with the greatest difficulty and require to be steered with great skill in order to accomplish successfully this sharp turn into a comparatively narrow and straight channel. The full width of this channel, about 150 feet, was originally dredged to a depth of 12 feet at low water. The survey shows that its present width is at some places only 80 feet, with a depth of water of only 10 feet at the junction with the main channel, where a decided tendency to the formation of a bar exists. The length of this dredged channel leading to the harbor is about 1,700 feet.

The harbor proper lies entirely within the land and begins 300 feet east from high-water mark on shore, the northern line of the entrance continued forming also the northern boundary of the harbor. It is a rectangular basin, about 780 feet long and 560 feet wide, the improved portion covering an area of about 10 acres, dug out mainly of the bed of a pond or small creek. This area was dredged to a depth of 11 feet below mean low water, and was inclosed at the same time on all sides, excepting a short space near the southeast corner, which was left open, with solid timber walls or bulkheads built upon piling, to a height of 7¾ feet above mean low water.

---

* Omitted; printed in House Ex. Doc. No. 29, Fifty-first Congress, first session.

These bulkheads, which are of a general width of 12 feet and decked over, are continued beyond the shore along each side of the entrance, on the north side 470 feet, on the south side 370 feet. These extensions in reality form piers, and were therefore built in a more substantial manner. In prolongation of these piers, rows of fender piles about 4 feet apart and connected by strong wale-pieces, were driven as far as the main channel to prevent vessels from grounding on the sides of the cut. The greater portion of these piles, however, have been destroyed and only the row on the south side is now being maintained.

A rapid dilapidation of all these works constructed of uncreosoted wood, including the bulkheads, is general, and may be properly ascribed to the teredo and the rough usage to which they are subjected by the constant and heavy traffic carried on by vessels whose capacity and size are out proportion with the space furnished for their evolutions.

For the transportation of freight and passengers, two passenger steamers of about seven hundred tons each and two powerful tugs of 600-horse power each are employed by the railroad company. The freight is carried across the bay in bulk upon four barges; each is 250 feet long and has sufficient deck room to carry from eighteen to twenty-six loaded cars.

The terminal facilities in the harbor consist of two floating slips on the east side, with an elaborate passenger depot adjoining, and, on the north side, of a freight depot 300 feet in length. On the south side several oyster-packing houses and one large ice-house have been erected. The city to the north of the harbor, which of necessity had to be added to these large improvements, more as a convenience to the employés of the railroad company than for other reasons, has at present about seven hundred inhabitants and has probably reached the end of its growth.

The harbor is in many respects excellent for the purpose for which it was built, namely, the transshipment of heavy freight. It affords safe shelter and calm water during the severest storms; but it can not be enlarged except at great expense if such a need should arise, and the establishment on its borders of industries connected with and related to shipping and navigation is therefore excluded and made difficult.

In this connection it may be stated that King's Creek, one mile to the north, and Plantation Creek, two miles to the south, of Cape Charles, appear to have offered greater natural advantages for a harbor.

Tidal observations were made on a tide-board located at the end of the north pier, outside the harbor, from July 17 until September 10, when the gauge was carried away during a northerly gale. A new gauge was established inside the harbor on the 13th following, and observations were continued until September 26. The plane of mean low water is 1.9 feet of this gauge, to which all soundings taken were referred. The rise and fall of the tide was found to be 2.68 feet; the highest high water observed was 4 feet above mean low water; the lowest low water 0.5 foot below mean low water, giving a total of 4½ feet for the greatest range observed. It is stated that during the prevalence of strong northwesterly winds the tide often falls from 2 to 3 feet below low water.

The demands of commerce as to the needed improvements in this harbor and the approaches thereto are specified in detal in the memoranda referred to in the preliminary report and furnished by the Hon. T. H. Bailey Browne, M. C., in whose Congressional district Cape Charles is situated. They may be classified, as therein indicated, under the head of "Dredging and the construction of protective works." The latter appear to be first in order of necessity and will be described first.

In the project herewith, the plan of the entrance has been somewhat changed. The width between the present inclosing works and their length is apparently not sufficient, nor is the direction of the outlet particularly suited for a proper maneuvering of vessels at the junction with the main channel. This direction, being normal to the channel, was probably adopted to save expense in dredging. Accepting the old piers as a base and their present ends as a starting point, the proposed entrance has been decidedly thrown to the southward by widening it funnel-shaped in that direction. Very few vessels sail to or from any place north of Cape Charles. The north pier is carried out for a distance of 1,000 feet in prolongation of the old pier as far as the edge of Cherrystone Inlet, and ends in 12 feet of water. The south pier, to begin at the end of the old bulkhead, is deflected southward 12 degrees for a length of 870 feet, then again 30 degrees for a length of 600 feet until it reaches the same depth of water as the north pier.

It will be observed that the sole object of these piers is to destroy the agitation of the sea in stormy weather, to make a safe entry, and to prevent in a manner the drift into the entrance of material carried along the shore by littoral currents. The width between them is determined by the space required to make ingress and egress easy for long tows. The piers are not jetties to be built to confine a current. The current going in and out of the harbor is hardly perceptible, and the water level inside merely rises and falls with the tide. It is, therefore, not necessary that their junction with the main channel should be of such a direction as to nearly coincide

with that of the prevailing current, the ebb current, though a more sheltered area against the prevailing northwest winds could thereby be obtained. To project the north pier much beyond the south pier would necessitate considerably more dredging now and in the future, as the flood tide coming up the channel would, by its own momentum, penetrate farther into the entrance and would silt it up more rapidly, and the ebb tide would cause proportionally larger deposits under the lee of the north pier. Whichever point is selected for the terminus of each pier, the tendency of the currents in the main channel will always be such as to close the entrance in the absence of any counteracting backwater from the harbor.

It is thought that this tendency towards shoaling can in a great measure be obviated by the extension of each pier as far as the edge of Cherrystone Inlet Channel. The movement of sand and clay, during both flood and ebb tides, over the flats along the shore is considerable when the winds are on-shore. In passing around the heads of the piers this material will suddenly meet the strong currents in the channel and the greater portion of it will likely be carried away before it finds time to lodge in the entrance.

The cheapest construction for these piers would be one of rubble-stone hearting roughly paved with larger stones. The bottom is sufficiently hard to permit the stones to be placed upon it without mattresses. The inside face should be steep, the outer one of a long slope. The general height should be carried to 8 feet above mean low water, and each pier should be rounded off at the end, with a broad, substantial head. The old wooden piers should be filled in with the same class of stones to high-water mark on shore, and the re-entrant angles there strengthened by revetments. Other details may have to be determined upon after Congress countenances this improvement by an appropriation.

The dredging project is a comprehensive one. The railroad company's officials state that, "to conduct the traffic devolving upon us, we find a channel 16 feet deep below mean low water absolutely necessary. It is not quite clear why such a depth is wanted, unless it is to make allowances for very low tides and rough seas, because the draught of water of their largest boat is 11½ feet. The depth asked for has been adhered to in estimating for dredging across Cherrystone Bar and in the channel of Cherrystone Inlet, and also within the entrance as far as the shore. Inside the harbor, where the water is more tranquil and where the stability of the works already built would be much endangered by a depth of 16 feet, a depth of 14 feet is deemed sufficient, though even that may prove an unsafe one for the harbor walls.

I am informed that the harbor, when being built about 4 years ago, was dredged to a depth of 12 feet for a width of about 250 feet south from the northern bulkhead, and the remainder to a general depth of 11 feet below mean low water. A total of 500,000 cubic yards of material was removed. By comparing the results of three surveys made by the railroad company, the first after completion of the harbor in October, 1885, the second in December, 1886, the third in January, 1889, supplemented by those of this survey, it is found that little filling in has taken place. The depths are remarkably permanent, notwithstanding the continued disturbance of the bottom by the deep propellers. The sluggish currents evidently carry but little sediment, or what there is of it is carried out again. The amount of material to be removed inside the harbor to a depth of 14 feet below mean low water is estimated at 60,000 cubic yards.

The surveys above referred to also show that within the entrance there is a tendency to shoaling, which begins at the junction with the harbor and runs out for a distance of about 600 feet. The 12-foot channel here is only about 40 feet wide, and at some points entirely interrupted. I am inclined to believe that this is mainly caused by sand, which is forced in under the bulkheads on either side, and which moves along the shore during storms. It is proposed to dredge the entrance to a depth of 16 feet, which will require the removal of 40,000 cubic yards of principally fine sand, the lines of dredging to extend to within 50 feet of the inner slopes of the piers.

The direction of the proposed channel down Cherrystone Inlet is different from the present one near its southern extremity. From opposite to the entrance of the harbor it follows the present course; but instead of keeping to the eastward of the black buoy until upon the line of the small range lights, it changes its direction at half the distance between the south pier-head and the black buoy and crosses the 11-foot bar, which interrupts the channel here, close by and to the westward of the buoy. This direction is to be permanently fixed as a range by the head-lights which will be necessary at the ends of the proposed piers, and a channel excavated along that line will require less excavation than it would if made along the present course. It is estimated that 57,000 cubic yards of material will have to be removed if this channel is made 100 feet wide and is dredged 16 feet deep. About one-half of the length of this channel requires dredging, the other half having an ample depth, especially at the lower end where it joins the course upon the present range lights.

The channel across the depression in Cherrystone Bar is proposed to be excavated along the course of the present range lights to a depth of 16 feet and for a width of

200 feet. The increase in width appears necessary to allow for rough weather and dark nights, and on account of the slightly oblique set of both the ebb and flood current across the bar. The length of this cut from the 16-foot curve in the Cherrystone Inlet to the 16-foot curve outside the bar will be 4,700 feet, and the estimated amount of material to be dredged is 70,000 cubic yards.

The total number of cubic yards required to be removed under the project herein submitted is $227,000. The proper disposition of so large an amount of material is an important question. It may be found of advantage, considering the great distance to which it has to be transported in case it is required to dump it into the deep water of the bay, to redredge it after some convenient point has been determined upon as a dumping-basin and to deposit it upon the adjoining shore with the aid of cars. Under no circumstances should it be deposited anywhere near or in Cherrystone Inlet. In this connection it may be mentioned that there is a remarkable hard knoll southeast of and near the black buoy in the channel, with only 5½ feet of water over it, which was presumably not made by nature alone, and which needs removal to the general level of the bottom surrounding it. It has been reported as a very dangerous obstruction.

The project for the improvement of the harbor of Cape Charles and approaches, submitted in this report, is strictly based upon the demands previously enumerated and expressed by those who desire the execution of these works by the General Government. No further extension or elaboration was attempted. It may not be out of place, however, to refer especially to the remaining necessity of sheltering the entrance to the harbor against the violent action of storms. Cherrystone Bar, just opposite, and on the bay side of the channel, offers unusual facilities and advantages for the construction of a breakwater at comparatively small cost. Such a breakwater might form the first step towards the construction of an outer harbor, by extending it northward sufficiently and by constructing under its shelter, of creosoted wood and iron, other piers and landings running out from the shore. This outer harbor, though naturally limited in available surface for anchorage, would form an excellent harbor of refuge for vessels drawing more than 6 feet of water, as there is no harbor of that kind and of sufficient depth to be found for many miles along this side of the bay. By referring to the records of the Department it may be noted that Cherrystone Creek, which is really nothing but the upper land-locked portion of Cherrystone Inlet, was examined in 1882, mainly to determine its adaptability for a harbor of refuge.

There is nothing to be added to the commercial statistics which were given in the report of the preliminary examination. For any information required on this subject I would respectfully refer to them.

Estimates.

a. Dredging:		
In the harbor	cubic yards	60,000
In the entrance	do	40,000
In Cherrystone Inlet on proposed range	do	57,000
Across Cherrystone Bar	do	70,000
Total	do	227,000
b. Works of protection:		
For extension of north and south piers and filling in present piers to the shore with rubble-stone	cubic yards	28,000
Estimated cost of dredging 227,000 cubic yards, at 20 cents		$45,400
Estimated cost of rubble works in place, 28,000 cubic yards, at $3		84,000
		129,400
Add 10 per cent. for contingencies		12,940
Total estimated cost of project		142,340

Very respectfully, your obedient servant,

A. STIERLE,
Assistant Engineer.

Gen. WM. F. SMITH,
United States Agent.

H 24.

PRELIMINARY EXAMINATION OF CHINCOTEAGUE INLET, VIRGINIA, FOR PURPOSES OF A BREAKWATER.

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., October 30, 1888.

GENERAL: In compliance with the requirements of section 14 of the river and harbor act of August 11, 1888, and the instructions contained in the letter from the office of the Chief of Engineers of September 29, 1888, I have the honor to submit the following report upon the preliminary examination of Chincoteague Inlet, for purposes of a breakwater, Virginia.

Chincoteague Inlet is situated in Accomac County, eastern shore of Virginia, about 60 miles south of the Delaware Breakwater Harbor. The roadstead east of the mouth of the inlet known as Tom's Cove is frequented as a harbor of refuge by coasting vessels sailing eastward and caught by northeasterly gales. It is, however, open to southerly and southwesterly winds, and is therefore dangerous. It is the only refuge between the capes of Virginia and those of the Delaware, and vessels that fear being caught on a lee shore by a sudden change of winds avoid it by running back to Hampton Roads.

The improvement would afford a secure harbor in stress of weather, and prevent much loss of time and danger to vessels in the coasting trade; it is, therefore, in my opinion, worthy of improvement and a survey is recommended.

The least amount required to make a survey, with report and estimate of improvement, is $1,000.

A breakwater constructed as desired, about 1 mile in length, would cost about $1,700,000.

A copy of the report of Mr. D. C. Hudson, who assisted in making the examination, is inclosed herewith.

Very respectfully, your obedient servant,

WM. F. SMITH,
United States Agent.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. D. C. HUDSON.

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., October 30, 1888.

SIR: In compliance with your order of October 10, 1888, I proceeded at once to Chincoteague Island, Virginia, and on the following day passed out of Chincoteague Inlet in a small steamer and ran across Assateague anchorage, commonly known in that section as Tom's Cove, to within a short distance of Fishing Point.

Assateague anchorage is situated nearly due east of the entrance to Chincoteague Inlet and is about half-way between the mouths of the Delaware and Chesapeake bays. In its present condition it is a fine natural roadstead for coasting vessels during dangerous northeast winds that frequently prevail on this coast. On the north and west complete protection is given by the shores of Chincoteague and Assateague islands. On the south, however, there is nothing to break the fury of the waves, and when the winds above referred to suddenly veer to that quarter great distress falls upon the storm-beaten traders that have taken refuge within this otherwise well-protected anchorage.

The distance from Chincoteague Inlet bar to Fishing Point is about 2½ miles. This point is said by persons living in its vicinity to be rapidly extending southward. If this be true the ship shoals are gradually being covered by the beach sands, thereby enlarging the roadstead and extending the protection against easterly storms.

The construction of a breakwater from some point east of Chincoteague Inlet across the cove to the small shoal south of Fishing Point would, if properly located and constructed, form a well-protected harbor more than a mile square, with a depth of water varying from 18 to 25 feet, with good holding bottom, and at all times accessible without crossing a bar.

A harbor at this point would be of inestimable value to the coasting trade. Northbound sailing vessels are often confronted with such strong head winds, when only a few miles south of the Delaware Breakwater, that they are compelled to turn and seek a place of safety southward. Assateague anchorage is a tempting present relief, but may bring sorrow in case of a sudden change of wind to the south. Chincoteague, Washapreague, and the two Machipongo inlets are eagerly watched, but if the weather is too thick to find a buoy, or if a buoy is found, a bar white with breakers often deters them from thus seeking a passage to the coveted and safe waters beyond, all the inlets are passed, a stormy cape that often robs them of a good part of their deck-load is crossed, and at last they are safely moored in Hampton Roads, having lost 100 miles of vantage ground held twelve or fifteen hours before.

Sailors in the coasting trade say that this is not an unusual occurrence. Scores of vessels are caught between the two bays by every northeast gale, and something oe the security to life and property that would result from such an intermediate placd of safety can readily be seen. At the custom-house on Chincoteague Island I learnen that more than one hundred vessels at one time had been known to take refuge if Assateague anchorage, risking a sudden change of wind rather than encounter the perils of a trip further south. In my opinion this anchorage is now about as safe as the Delaware Breakwater harbor, and, with the improvement suggested, would form a complete harbor, easy of access, deeper, and of more than twice the safe capacity of the Delaware Breakwater, and without an Henlopen to cross.

I learned also that one hundred and three vessels, varying from 5 to 65 tons, trade in and out of Chincoteague Inlet, together with about two hundred smaller vessels, under 5 tons, and decked. From twelve to fifteen vessels trade in pine wood, each making about twelve trips per year. The smaller boats carry oysters to Philadelphia and points on the New Jersey coast. They also bring plants from the Chesapeake Bay, at the regular seasons, to be placed on the numerous oyster beds in Chincoteague, Johnson's, and Parker's bays. Quite an extensive business in sea-fishing is carried on.

On the morning of the day this examination was made twenty-five or thirty vessels of the smaller fishing vessels had passed out of the inlet and were found lying in Assateague anchorage awaiting the developments of the weather. An increasing northeast storm held them at bay and drove them within the inlet. By noon a regular gale had set in and we too were obliged to seek a place of safety and defer our trip up the bay until the following day. Vessels trading out of this inlet find the anchorage a very convenient place to wait for daylight or fogs to clear up on their return trips to enable them to find the way over the bar.

It is roughly estimated that a breakwater 1 mile long would cost about $1,664,663. Before any details can be given an accurate survey must be made, and it is estimated that it would cost $1,000.

Very respectfully, your obedient servant,

D. C. HUDSON.

General WM. F. SMITH,
United States Agent.

SURVEY OF CHINCOTEAGUE INLET, VIRGINIA, FOR PURPOSES OF A BREAKWATER.

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., February 4, 1890.

GENERAL: In compliance with the instructions contained in the letter of April 6, 1889, from the office of the Chief of Engineers and the requirements of the river and harbor act of August 11, 1888, I have the honor to submit the following report upon the survey of Chincoteague Inlet, Virginia, for purposes of a breakwater, made under my direction during the month of August, 1889.

There can be no doubt about the benefit arising to commerce from the establishment of a harbor of refuge midway between the capes of Virginia and those of the Delaware. The limit to which expense for such a harbor should go is another question.

The jetty proposed from the mainland south of the Chincoteague Inlet

would doubtless be of great service in improving that inlet in accordance with the scheme for an inland water-way from Chincoteague Bay to Delaware Bay, near Lewes, Del.

The project and estimates taken from the report of Mr. A. Stierle, the assistant engineer who made the survey, are for a breakwater 12,000 feet long, a jetty on Wallop's Beach 10,250 feet long, and a jetty at Fishing Point 4,900 feet long, at a total estimated cost of $3,782,688.

A copy of the report of the assistant engineer is herewith inclosed.

A tracing of the map of the survey is now being made and will be forwarded as soon as completed.

Very respectfully, your obedient servant,

WM. F. SMITH,
United States Agent.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. A. STIERLE, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., February 3, 1890.

GENERAL: I have the honor to submit herewith a report upon the survey of Chincoteague Inlet, Virginia, made under your direction for purposes of a breakwater, and in conformity with the intention of this requirement a project for the location and construction of such a work.

The order directed the survey to be made for the purpose of a breakwater. This was understood to mean for the purpose of establishing a harbor protected by a breakwater. The inlet itself, with its broad channel and mouth to the rear of it, is not available for that purpose. It is too dangerous to enter in rough weather, and full of subsidiary narrow channels with dry intervening banks. It was assumed, therefore, that the scope of the examination was to embrace mainly the deep cove in the shore-line immediately north and east of the inlet, and the adjacent sheet of water commonly called Assateague anchorage, which presents many natural advantages for the construction of such a harbor.

The survey was made during the month of August, 1889. I had the good fortune to obtain a boat-crew of picked men, all members of the Assateague Life-Saving Station, whose local knowledge was of great value, and whose steady and intelligent services aided materially in the furtherance of the survey. The most prominent points of the shore were located by triangulation, which commenced at a base line 3,709.70 feet long, measured on Assateague Beach; intermediary portions of the shore were located by sextant angles. The shore-line was thus accurately located, and extended on the north side of the inlet from a point due east of Assateague Light to the fish factory, inside the inlet; and on the south side from opposite this factory to the life-saving station on Wallop's Beach. The hydrography of about 12 square miles of water immediately south of the shore was examined, and mid-depth current observations were made at various points within this area, at both flood and ebb tide. Two tidal stations were established, one just inside of Assateague Channel, where observations were made from August 9 to 31, and one in Power's Cove, back of Fishing Point, were observations were made for seven days.

The mean rise and fall of the tide at the former gauge for the period of observation was 3.41 feet; at the latter gauge 3.45. The average duration of flood is six hours and eight minutes; the average duration of ebb, six hours and seventeen minutes. During the surveys of Chincoteague Shoals, made in 1881 and 1887, by the Coast Survey Department, a tide-gauge had been established about one mile inside of Chincoteague Inlet. The rise and fall of the tide as determined from about one month's observations the first year and from about one-half of a month's observations the second year was 3.19 and 2.64 feet respectively. It was the intention to compare the mean low-water plane established by the Coast Survey Department with that of the present survey, but the bench-marks had been destroyed some time since by the rebuilding of the wharf where they had been located.

The soundings were reduced to mean low water of the gauge in Assateague Channel. This mean low water is probably from two to four-tenths of a foot lower than that used by the Coast Survey Department, assuming in all cases the plane of mean sea-level (half tide) to be the same. For future reference, however, a permanent bench-mark was established near the gauge, which is 8 feet above zero or 6.88 feet above the mean low water of August, 1889.

Only four days were sufficiently calm during the progress of the survey to permit of current observations to be made. These were necessarily limited to a small section of the very large area that had to be examined and were made principally along the interior of the outlying shoals and Fishing Point, the space that appeared at first sight to be most available for a harbor. A weighted tin can, reaching as near as practicable to mid-depth, was suspended on a fine cord from a small surface float and set adrift at different stages of the tide. The course of the float was located at stated intervals by sextent angles and the time which elapsed between the different stations noted. The direction and velocity were thus readily ascertained on the chart after being plotted.

The set of the flood current south of Turner's Shoal is in a northwesterly direction, turning sharp to the southwest after entering the anchorage. Between Turner's Shoal and Fishing Point the same current enters in a westerly direction and spreads to the northward after passing the point, the stronger drift going up along the inner shore of Fishing Point. At none of the stations where observations were taken did the mid-depths velocity of the flood current exceed 0.7 of a foot per second. The direction of the ebb current is everywhere north of a line drawn from Turner's Shoal to the bar at Chincoteague Inlet parallel to the general direction of the shore, with velocities varying from 0.1 to 0.8 of a foot per second, the strength increasing only toward the last stages of the ebb simultaneously with a decided set in the direction of the gap between Turner's Shoal and Fishing Point.

A comparative chart accompanies this report (Sheet No. 2), which shows the changes that have taken place during the past forty years in the shore-line around Assateague anchorage and Chincoteague Inlet and during the past eight years in the most characteristic contours of the bottom. This chart most clearly shows a rapid increase, in a southwesterly direction, in the growth of Fishing Point, a promontory of quite recent formation on the east side of the anchorage. Since 1850 this point has advanced 2¼ miles. In that year the high-water line ran across the base of the present point in an easy curve, scarcely showing any indications of a point, except under water. A survey of the shore, made in 1872, locates the well-developed hook of the point already 1 mile to the south of the shore of 1850. Subsequent surveys enable us to measure the growth more accurately. The extension seems to follow a perfectly straight line when drawn through the extreme points of the different surveys, which makes an angle of 12½ degrees with the true meridian, and amounted to 3,450 feet between the years 1872 and 1881 and to 2,520 feet from 1881 to 1889, or on an average about 350 feet per year. With its advance the extreme end has become more acute, though the general width to the rear has nearly doubled since 1881 and is now 2,000 feet.

The long stretch of concave shore to the north of the anchorage appears to have remained stationary until 1881. Since that year it has also advanced about 900 feet from the middle to the western end of Assateague Channel. The general configuration of the mouth of this channel and along the northeast shore of Chincoteague Inlet has changed but little, with the exception of the extreme westerly point, where the fish factory is now located, which has been cut away by the ebb current 600 feet. The shore southwest of the inlet appears to have advanced some, though the differences shown by the chart may have arisen from the fact that the shore being very flat a slight rise or fall of the water-level at the time the different surveys were made would necessarily move high-water mark several hundred feet in or out, as the case may be. The shore along Wallop's Beach has practically remained the same.

A comparison of the contours of the bottom between the years 1881 and 1889 discloses a general shoaling throughout the anchorage below the 6-foot depth. All the contours have moved southward, the 24-foot curve the most, and in a direction nearly coincident with that of Fishing Point. This movement is equivalent to a reduction in depth of from 2 to 3 feet within the time named.

By the courtesy of Capt. J. T. Tracy, keeper of Assateague Life-Saving Station, I was enabled to obtain certain valuable data in relation to the prevailing winds on this part of the coast. A record of the weather has been kept here for many years. Unfortunately, however, this record lacks method for want of a scientific basis. Particularly is this the case with reference to the force of the wind, which is recorded from individual impressions only, and not upon a fixed scale, as adopted elsewhere, which would be of more practical value. I have selected from the long record kept by the captain the daily observations about the wind for the five years from 1884 to 1888, inclusive, and after a patient investigation to get at his personal equation as to the meaning of the force of the wind as entered into his journal, which contained such inapposite terms as "moderate gale," "strong breeze," etc., a classification of the wind was made, embracing five groups, viz, calm, light, moderate, strong, and gale, which is supposed to be approximately correct.

According to the table there occurred during these five years nine calm days; on ninety days the wind was light, on six hundred and thirty fresh, on one thousand and two strong, and on ninety-six days a gale was blowing. Of the latter, which together with the stong winds are of more importance in connection with the subject

matter of this report, twenty-seven were from the northwest, thirteen from the northeast; the next lowest number, eight each, from the south-southeast and west-northwest; seven each from the south and north-northeast; the remainder being nearly equally distributed over all points of the compass, except that there was none from the east. The prevailing direction of the wind was in the following order for those above the average: Northeast, northwest, southwest and south-southwest. Taking, however, the means of four successive points of the compass all around, to eliminate any possible error arising from a too close habit in the observer to adhere too much to certain directions, the prevailing winds appear in four groups in the following order: From the south to west; north to east; north to west; and south to east.

A compilation of the strength of the wind was made in a similar way after a certain mean velocity had been fixed upon for the days—classified as light, moderate, strong, and gale. The square of the mean velocity multiplied by the corresponding number of days gives the total wind pressure from a certain direction. The result showed that the greatest total pressure occurred from the north to the west, upon which follow the quadrants from the south to west, north to east, and south to east. Taking each point individually, however, the strongest pressure occurred from the northwest, northeast, and south, in the order named. With few exceptions, the course of the gales recorded was, "with the sun," and rarely comprised more than one-quarter of a circle.

It appears that the demand for locating a harbor of refuge on this part of the coast has been entertained for many years. The necessity arose mainly from the long unbroken coast line between Cape Henlopen and Cape Charles offering no place for shelter in case of storms suddenly arising. In such an emergency the smaller class of vessels have heretofore taken and still take the risk of anchoring in Assateague Cove; the larger class stand to sea, or turn back to the capes. It is assumed, therefore, that the benefit to be derived from the construction of a harbor of refuge at this inlet would principally affect the small vessels engaged in oystering, fishing, and trading in and out of the many inland bays of the adjoining coast, and also the larger vessels, commonly called coasters, which navigate along the Atlantic coast and embrace steamers as well as sailing vessels. There is no reason, however, why also the vessels sailing to and from foreign countries should not avail themselves of such an opportunity for a stopping place to wait for or receive orders, situated, as it would be, about midway between Baltimore and Philadelphia.

Considering all the physical conditions as described above, the site is not a very eligible one for the construction of a harbor of refuge except at great cost. It is in its greater portion exposed to the severest gales, which generally occur from the northeast to the southwest. The shore is so flat that it offers no shelter against the gales blowing from other points of the compass. The very outline of the shore indicates its unfixed character, its state of transition causing an unfavorable interference in the littoral currents, which creates the counter-currents that make the cove back of Fishing Point the depositing ground for the material transported up and down the shore by the waves and currents. There are, however, two very favorable features which this site possesses: First, the character of the bottom, especially in the deeper portions, is such as to give a firm holding-ground for anchors; and second, within its borders are two outlets of Chincoteague Bay, an immense natural reservoir for scouring purposes.

It would appear from the above that the construction of a harbor inside or north of a line extending from Fishing Point to the northern point of Chincoteague Inlet would be followed immediately by its own destruction. The counter-currents and action of the waves that keep this cove now comparatively free from deposits would be excluded and shoals would form under the lee of Fishing Point and any works that might be constructed. This cove presents at first sight many advantages, and is now, as above stated, the anchoring-ground used by small vessels; but it is clear that any change, artificial or otherwise, made in the conditions surrounding its present state must produce effects detrimental to the purpose under consideration.

An area more suitable for a harbor exists within the deep-water pocket which enters immediately west of Turner's Shoal. Although the same objections may be applied in a certain degree to this portion as to the others, it is nevertheless already measurably beyond the prevailing pernicious influence of the currents and susceptible of more permanent improvement.

The project herewith submitted provides for a breakwater running westerly from Turner's Shoal, and for two shore jetties, one to extend from Wallop's Beach in an east-southeasterly direction, the other to be built along the line upon which Fishing Point is advancing. The points principally kept in view in locating these works are: To shelter the anchorage from the heavy seas rolling in from the ocean; to leave an entrance on the east and west side of the harbor through which the currents may pass in their alternate motion and to allow vessels to make harbor under any wind; to provide for the possibility of future shoaling by keeping the location well off-

shore; and lastly, to direct as near as is possible under the present conditions the ebb current flowing out of Chincoteague Inlet in such a manner that the largest body at least will go out through the channel in the gap between Turner's Shoal and Fishing Point.

The total length of the breakwater is 12,000 feet. Its general direction is normal to the prevailing direction of the waves. The heavy ocean swell never enters this indentation in the coast line from the east, as will be made clear by the inspection of a coast chart of this section. There exists a peculiar formation of reefs off Fishing Point, extending from south-southwest to east-northeast for a distance of about five miles from the shore. These reefs are known under the name of Chincoteague Shoals, and are curvilinear in form and parallel to each other, their convex side being presented to the ocean. They follow each other at almost regular distances, their radii having a common center, which lies on shore about 1½ miles back from the present extreme end of Fishing Point. During any storm and strong winds that blow towards, and even up and down the shore, the long line of waves break over these shoals on encountering them; the portions not meeting with any obstacle continue with an apparent accelerated velocity in the deeper water south of the shoals; and their northern end being retarded, the waves gradually wheel around, resulting in a change of direction almost due north when arriving behind Turner's Shoal, and often nearly into "the face" of the wind.

For these reasons the direction of the breakwater was established as indicated, and it has in this position the further advantage of presenting the least obstruction to the flow of the littoral currents. The main portion consists of two long, central arms, one 3,000 the other 6,000 feet long, joining at an angle of 153 degrees measured on the south side. Recent experiences have demonstrated the utility of building long breakwaters in this form, with the concave side toward the direction of the heaviest seas, to concentrate their force and movement at and towards the center instead of near the ends where the entrance is generally located. For the same purpose a shorter arm, 1,000 feet long, is added to the west end of the main body at about the same angle of deflection to protect the western or main entrance. From the east end of the longest branch of the breakwater a shorter arm, 1,200 feet long, is thrown across Turner's Shoal in a northeasterly direction. This section is to prevent partially, in connection with the jetty from Fishing Point, the projection of waves into the harbor during easterly and southeasterly gales.

The jetty extending from Wallop's Beach may be said to answer two important purposes: First, to arrest the progress of the material drifting northwardly along the shore to prevent further encroachments upon the harbor from that direction; and, second, to create still water over the bar of Chincoteague Inlet and in a measure to assist the ebb current in deepening it. The length of the jetty as proposed is 10,250 feet. The jetty thrown out from Fishing Point is to protect the harbor on the east against both wind and waves. The length as laid down on the chart is 4,900 feet. It is located nearly in prolongation of the axis of Fishing Point, upon which the latter is still advancing, to assist nature's work, although it is possible that since its construction would introduce an element of disturbance in the present regimen, in connection with the other proposed works, it may be necessary to build it out with great caution, and to watch the effects continually, with the view of changing its direction if necessary. The same maxim of cautious proceeding holds good for the breakwater as well as the jetty on Wallop's Beach.

The estimate given below is for works 25 feet wide across the top and extending to a height of 14 feet above mean low water.

The material proposed is a hearting of rubble-stone covered with larger stones, laid with some regularity on the outside. The inner slopes to be generally at the rate of 1 foot in 1, the outer slopes to be 1 to 1 from the bottom up to low-water level, 1 in 6 to high-water level, and then perpendicular breastwork to the top. That portion of the slope on the outside, between the levels of low and high water, is to be particularly re-enforced with heavy blocks not less than from 10 to 20 tons in weight.

For information concerning the extent of the local commerce of Chincoteague Inlet and Bay I would respectfully refer to the report upon the preliminary examination; to what extent the general commerce along the Atlantic coast would be benefited by the construction of this harbor has also been stated therein and in this report. It may be stated here, in addition, that Chincoteague Inlet is to form the southern terminus of the inland water-way now in process of construction between Chincoteague Bay and Delaware Bay, and its improvement receives, therefore, additional importance.

Estimate: (*a*) For a breakwater 12,000 feet long; (*b*) for a jetty at Wallop's Beach 10,250 feet long; (*c*) for a jetty at Fishing Point 4,900 feet long. Total number of cubic yards of stone, 1,260,896, at $3 per cubic yard, $3,782,688.

Very respectfully, your obedient servant,

A. STIERLE,
Assistant Engineer.

General WM. F. SMITH,
U. S. Agent.

APPENDIX I.

IMPROVEMENT OF PATAPSCO RIVER AND CHANNEL TO BALTIMORE, MARYLAND, AND OF JAMES RIVER, VIRGINIA.

REPORT OF COLONEL W. P. CRAIGHILL, CORPS OF ENGINEERS, U. S. ARMY, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1890, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Patapsco River and Channel to Baltimore, Maryland.
2. James River, Virginia.

HARBOR LINES.

3. Establishment of harbor-lines in the James River from Richmond to City Point, Virginia.

UNITED STATES ENGINEER OFFICE,
Baltimore, Md., July 8, 1890.

GENERAL: I have the honor to forward herewith the annual reports for the year ending June 30, 1890, for the works of improvement of rivers and harbors which have been in my charge.

In cases where the commercial statistics may not be as full and complete as desirable, it is not for want of desire and effort on my part to have them so.

During the year I have been division engineer of the southeast division, member of the Light-House Board, and of a number of special boards.

Very respectfully, your obedient servant,

WM. P. CRAIGHILL,
Colonel, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

I 1.

IMPROVEMENT OF PATAPSCO RIVER AND CHANNEL TO BALTIMORE, MARYLAND.

The act of August 11, 1888, appropriated $300,000, with which the improvement was vigorously continued under contract until the end of August, 1889, when operations were brought to a close for want of funds. The depth of the channel was already 27 feet at low water, by

which access was afforded to Baltimore by ships of the heaviest tonnage. With this apropriation great improvement in the width of the channel has been made, especially at the angles.

Money statement.

July 1, 1889, amount available	$148,193.89
July 1, 1890, amount expended during fiscal year, exclusive of liabilites outstanding July 1, 1889	102,564.38
July 1, 1890, balance available	45,629.51
Amount appropriated by act of September 19, 1890	340,000.00
Amount available for fiscal year ending June 30, 1891	385,629.51
Amount (estimated) required for completion of existing project	360,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	360,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

LETTERS OF THE COLLECTOR OF THE PORT OF BALTIMORE.

1.

CUSTOM-HOUSE, BALTIMORE, MD.,
Collector's Office, July 8, 1890.

DEAR SIR: In reply to your request of the 31st of May, for a statement of the tonnage movement at this port for the fiscal year ending June 30, 1890, I beg to hand you the following:

	Foreign.			Coastwise.	
	1888–'89.	1889–'90.	Increase.	1889–'90.	Increase.
	Tons.	*Tons.*	*Per cent.*	*Tons.*	*Per cent.*
Inward	478,362	830,384	73	1,062,810	5
Outward	672,438	1,113,290	64	1,218,325	

Referring to the above statement of coastwise tonnage movement, I would state that it only represents about one-half of the coastwise trade at this port, as the law only requires American vessels under certain circumstances while in the coasting trade to enter and clear at the custom-house.

So far as I can ascertain, there have been no new steam-ship lines established here during the past year, although the existing lines have added additional ships.

I inclose herewith a memorandum of the established lines.

In reviewing the statistics of the fiscal year just closed, it is very gratifying to note the vast increase of the tonnage movement at this port, and I conclude that it is owing to the safety of our channel, the exceptionally favorable advantages of cheap port charges, quick dispatch, and short haul from the grain fields of the great West, and I take it that the future of Baltimore is full of promise.

Yours, very truly,

WM. M. MARINE, *Collector.*

Col. WM. P. CRAIGHILL,
Corps of Engineers, U. S. A.

Allen Line, Liverpool.
N. German Lloyds, Bremen.
Wilson Line, Hull and Antwerp.
Neptune Line, Rotterdam.
Earn Line, Cuba.
Johnson Line, Liverpool, London, etc.
Atlantic Transport Line, London, Belfast, Glasgow, Bristol, Hull, etc.
Hooper's Line (Spanish), Liverpool.
Red Cross Line, Rio, Pernambuco, etc.
Sloman's Line, Rio, Pernambuco, etc.

The above are the established steam-ship lines between Baltimore and the points named.

2.

CUSTOM-HOUSE, BALTIMORE, MD.,
Collector's Office, July 29, 1890.

SIR: In compliance with the request contained in your letter of 22d of May last, you are herewith furnished with an abstract statement, as of record in this office, of the commercial trade of the port of Baltimore for the fiscal year ending June 30, 1890:

Value of free imports 1889	$7,673,520
Value of free imports 1890	5,149,595
Decrease	2,523,925
Value of dutiable imports:	
1890	8,027,525
1889	7,607,174
Increase 1890	420,351
Recapitulation:	
Value of free imports 1890	5,149,595
Value of dutiable imports 1890	8,027,525
Total 1890	13,177,120
Value of total 1889	15,280,694
Decrease 1890	2,103,574
Imports brought in American vessels:	
Sail	3,314,132
Steam	38,062
Imports brought in foreign vessels:	
Sail	187,564
Steam	9,635,811
Imports brought in cars overland	1,551
Total	13,177,120
Recapitulation:	
In American vessels	3,352,194
In foreign vessels	9,823,375
In cars	1,551
Total	13,177,120

The decrease in free imports is confined to a few leading articles—coffee chiefly. Importations in coffee fluctuate in volume in a marked degree. In 1889 the imports were $5,548,701, in 1888 $2,473,067, increase in 1889 $3,075,634, increase in 1890 over 1888 $775,005.

Value of exports:	
1890	$73,967,769
1889	50,603,215
Increase	23,364,554
Exports carried in American vessels:	
Sail	1,657,480
Exports carried in foreign vessels:	
Sail	309,939
Steam	72,000,350
Total	73,967,769
Recapitulation:	
American vessels	1,657,480
Foreign vessels	72,310,289
Total	73,967,769

The value of exports of this year is greater than that of many preceding years except 1880, when the exports in value reached $77,125,022. Of this amount the value

of wheat was $43,573,529, leaving for the general line of merchandise $33,551,493. This year the wheat value is $5,349,465, an increase of $2,192,759 over last year. The wheat value of $5,394,465 taken from the total $73,967,769 leaves $68,573,304 as against $33,551,493 of 1880 for the general line of merchandise. This state of trade in exports is a marked and notable showing and has no comparison in previous years.

Certain articles of merchandise exported.

Articles.	Tons.	Articles.	Tons.
Corn	577,229	Fresh beef	396
Wheat	170,448	Tallow	12,847
Flour	262,607	Lubricating oil	2,667
Cotton	27,324	Bacon	4,191
Dried apples	2,562	Hams	736
Grape sugar	955	Pickled pork	1,111
Hops	582	Lard	27,774
Sole leather	88	Butter	141
Rosin	11,345	Cheese	600
Oil-cake	25,481	Clover-seed	4,280
Lard oil	760	Timothy-seed	1,606
Illuminating oil	36,707	Starch	2,637
Canned beef	13,658	Leaf-tobacco	24,655
Cotton-seed	864	Bituminous coal	34,862
Copper silver matte	8,763	Copper matte	21,343
Salted beef	6,620		

Three hundred and ninety-six tons of fresh beef were exported during the year. This is a new enterprise, and may become a valuable trade. The meat is preserved during the voyage by means of cold-storage fitted up at much cost on the steam-ship. The meat is shipped from Chicago in cold-storage cars, and immediately upon arrival is put upon the steam-ship in the cold-storage chamber.

Transportation in bond, with appraisement.

Destination.	Value.	Duties.	Destination.	Value.	Duties.
Philadelphia	$3,257	$2,539.45	St. Louis	1,614	564.90
Chicago	857	769.60	Georgetown	2,502	881.80
Milwaukee	926	274.20	Alexandria	1,342	522.23
Pittsburgh	10,493	6,154.65	Wheeling	817	420.65
Kansas City	3,946	3,010.70			
New York	3,763	2,380.88	Total	29,517	17,519.66

Transportation in bond, without appraisement.

Destination.	Value.	Destination.	Value.
St. Louis	$472,204	Memphis	5,760
St. Paul	20,541	Evansville	8,219
Pittsburgh	159,693	Denver	4,350
Minneapolis	1,512	Toledo	12,318
Milwaukee	159,506	Philadelphia	3,616
Louisville	194,223	New York	1,211
Indianapolis	179,902	Buffalo	4,493
Georgetown	36,040	Grand Rapids	890
Detroit	13,850	Charleston, S. C	1,155
Columbus	13,609	Kansas City	8,071
Cincinnati	331,378		
Cleveland	93,265	Total	3,036,260
Chicago	1,311,674		

Summary of merchandise in bond without appraisement.

Year.	Value.	Duty.
1890	$3,036,260	$1,326,344.07
1889	3,020,335	
Increase	15,925	

Number of immigrants and passengers arriving:	
1890	31,606
1889	30,544
Increase	1,062
Amount of duties collected	$2,864,767.52
Miscellaneous customs receipts	87,060.31
Total 1890	2,951,827.83
Total 1889	2,926,659.29
Increase	25,168.54
Duties due on merchandise in bond:	
1890	$132,104.20
1889	90,787.11
Increase	41,317.09

Summary of duties collected and duties due on merchandise transported in bond.

Duties, etc., collected	$2,951,827.83
Duties on merchandise in bond	132,104.20
Duties due on merchandise in bond with and without appraisement	1,343,863.13
Total	4,427,795.16

Vessels built.

Year.	Number.	Gross tonnage.	Net tonnage.
1890	26	4196.11	3197.35
1889	21	3466.38	2774.74

Entrances and clearances.

	Tons.	
Vessels entered from foreign ports:		
American:		
Sail	59,951	
Foreign:		
Sail	20,494	
Steam	751,289	
		831,734
Vessels cleared for foreign ports:		
American:		
Sail	40,967	
Foreign:		
Sail	12,260	
Steam	1,071,265	
		1,124,492
Total foreign, 1890		1,956,226
Total foreign, 1889		1,150,800
Increase 1890		805,426
Vessels entered coastwise		1,062,810
Vessels cleared coastwise		1,218,325
Total 1890		2,281,135
Total 1889		2,092,217
Increase 1890		188,918

RECAPITULATION.

Foreign tonnage inward and outward	1,956,226
Coastwise tonnage inward and outward	2,281,135
Total 1890	4,237,361
Total 1889	3,243,017
Increase	994,344

Many vessels in the coastwise trade are not required to enter and clear at the custom-house; hence the tonnage of vessels so trading is not of record. From information obtained from those engaged in that branch of the coasting trade it may be fairly estimated that the tonnage not of record in the coastwise trade is nearly the same as that of record.

The tonnage of merchandise carried coastwise is not available as matter of record. It may, however, be fairly estimated.

The total record tonnage of the trade is	2,281,135
That not of record, estimated at two-thirds	1,520,756
Total	3,801,891
The above is the net tonnage; the carrying capacity is fully one-third more	1,276,295
Carrying capacity, total	5,069,186
Allowing one-third for vessels in ballast and short cargoes	1,689 726
Merchandise tonnage	3,379,460

This trade runs with the Atlantic sea-board, the Gulf of Mexico, and the Pacific coast to San Francisco. Coal, ore, ice, lumber, and resin are among the chief articles of trade, together with the products of the farm, mine, and mill.

STEAM-SHIP LINES.

The several lines running to this port have been strengthened during the year by the addition of newly built ships and the chartering of ships from foreign lines. Newly built ships are to be added during the coming year.

CARRYING CAPACITY.

The carrying capacity of steam-ships running to this port vary from 2,000 to 6,000 tons, with a draught of water from 20 feet to 27 feet. The tendency is toward building ships of greater carrying capacity and heavier water draught.

STATISTICS.

It is evident, from the figures of this statement, that the commercial trade of the port during the year has been maintained with marked vigor and has shown notable growth.

Dutiable merchandise has increased in value	$420,351
Exports have increased in value	$23,364,554
Total tonnage of record has increased, foreign and coastwise ..... tons	994,344
Total foreign tonnage has increased ..... do	805,464
Duties collected and due on merchandise in warehouse	$66,485.63
Increase in vessels built ..... number	5

Respectfully, yours,

W. M. MARINE,
Collector.

Col. WM. P. CRAIGHILL,
Corps of Engineers, U. S. A.

I 2.

IMPROVEMENT OF JAMES RIVER, VIRGINIA.

The improvement was regularly undertaken by the United States in 1870. A small sum had been previously expended and was of some advantage to navigation. The appropriation of 1870 was $50,000. Since that year others have been made. The last was $225,000, August 11, 1888. The total expended by the United States on the river to July 1, 1890 has been $1,163,677.34. In addition, the city of Richmond has expended nearly $500,000.

When the improvement was undertaken by the Government, navigation was obstructed by sunken vessels, by remains of military bridges, and by obstructions put in the river during the late war to prevent the National fleets from approaching too close to Richmond. There were, besides, natural obstructions.

Rockett's Reef and Richmond Bar had only 7 feet of water at mean

low tide. From Warwick Bar (where the depth was 13 feet) to Richmond the channel was crooked and obstructed by dangerous rocks and ledges. The Dutch Gap Cut-off, which now saves 5½ miles of difficult navigation, was not then open.

The original project was to secure a depth of 18 feet at full tide, corresponding to 14.5 at low tide, to Richmond, with a channel width of 180 feet from Harrison's Bar to Richmond Docks, the excavation in rock to be 18½ feet at full tide. This plan was well advanced when Congress, by act approved July 5, 1884, adopted the project of 22 feet at mean low tide from Richmond to the sea. Operations during the past year have been conducted in accordance therewith. In carrying it out further a large amount of excavation will be in solid rock, and the cost will necessarily be great. The width to be given to the channel is 400 feet from the sea to City Point, 300 feet from City Point to Drewry's Bluff, and 200 feet from thence to Richmond. The methods employed for improving the river consist in dredging, rock excavation, and the construction of the water-way by means of dikes or jetties.

Mr. C. P. E. Burgwyn has continued the efficient resident engineer of the work. His detailed report is appended.

On application to the Secretary of War as to the need of the establishment of harbor-lines, action was taken by him on the subject for the portion of the river between Mayo's Bridge, at Richmond, and Drewry's Bluff.

Money statement.

July 1, 1889, amount available		$70,723.35
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$69,137.48	
July 1, 1890, outstanding liabilities	800.00	
		69,937.48
July 1, 1890, balance available		785.87
Amount appropriated by act of September 19, 1890		200,000.00
Amount available for fiscal year ending June 30, 1891		200,785.87
Amount (estimated) required for completion of existing project		3,736,070.45
Amount that can be profitably expended in fiscal year ending June 30, 1892		400,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for construction of brush dikes, improving James River, Virginia, opened October 8, 1889 at 12.05 p. m.

No.	Name and address of bidder.	Commence.	Complete.	Style A (1580 linear feet).		Style B (1220 linear feet).		Style C (620 linear feet).		Style D (1610 linear feet).		Total.
				Cost	Amount.	Cost	Amount.	Cost	Amount.	Cost	Amount.	
1	Wm. T. Gaynor, Fayetteville, N. Y.	1889. Dec. 1.	1890. May 1.	$1.50	$2,370.00	$1.50	$1,830.00	$1.50	$930.00	$1.70	$2,737.00	$7,867.00
2	J. F. Bradley, Manchester, Va.	Oct. 20.	Jan. 31.	2.39	3,776.20	1.39	1,695.80	1.29	799.80	3.39	5,457.90	11,729.70
3	C. Powell Noland, Richmond, Va.	10 days.	July 1.	3.75	5,925.00	1.95	2,379.00	1.90	1,178.00	4.99	8,033.90	17,515.90

Contract with Wm. T. Gaynor.

Abstract of proposals for dredging at Kingsland Reach, improving James River, Virginia, opened October 26, 1889, at 12.05 p. m.

No.	Name and address of bidder.	Commence.	Complete.	Per cubic yard.	Total.
1	Morris & Cummings Dredging Company, New York, N. Y.	Ten days.	Two months.	$0.20	$6,000
2	Chester T. Caler, Norfolk, Va.	Nov. 10, 1889.	Jan. 1, 1890.	.18	5,400

Price too high. All rejected.

Abstract of proposals for building one scow, improving James River, Virginia, opened January 7, 1890, at 12.05 p. m.

No.	Name and address of bidder.	Commence.	Complete.	Amount.
1	George W. Donly, Richmond, Va.	February 1, 1890	Apr. 15, 1890	$1,399.00
2	John W. Roger, John D. Riddell, Richmond, Va.	do	do	1,925.00
3	H. Brusstar & Bro., Baltimore, Md.	Receiving contract	Apr. 1, 1890	*1,305.96
4	John L. Thomas, Portsmouth, Va.	Twenty days from date	Apr. 15, 1890	2,650.00
5	James Woodall, Charles A. Witler, Baltimore, Md.	At once	do	*1,850.00
6	H. T. Morrison & Co., Petersburgh, Va.	Receipt of contract	do	1,540.00
7	W. M. Hope, Portsmouth, Va.	do	do	2,457.00

* Deliver at Norfolk, Va.

Contract with H. Brusstar & Bro.

REPORT OF MR. C. P. E. BURGWYN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Richmond, Va., June 30, 1890.

COLONEL: I have the honor to submit the following report of operations connected with the improvement of the James River for the fiscal year just ended.

At the commencement of the year, viz, July, 1889, the operations connected with the improvement of the river were in continuance of the work of last year and consisted in dredging material from Stearn's Dike Cut, in excavating material at Dutch Gap, in excavating material from Goode's Rock Cut, and in certain survey work. The field work of this survey was completed in July. It was merely in keeping with the usual local survey work necessary.

STEARN'S DIKE CUT.

This work was prosecuted as steadily as the phenomenal freshet water would permit during the months of July, August, September, October, and November, 1889. Of the material excavated 16 per cent. was solid rock, the remainder consisting of gravel and a disintegrated granite. All the material taken out was used for purposes of revetment, protection of the ends of wing dams, and for raising and strengthening old training-walls. The work was greatly interfered with by a series of freshets, the most extraordinary of any that have yet occured on the James. Thus during August there were two, although no freshets had ever been known during that month before; in September there were three; in October one, and in November two. As each freshet was accompanied by strong water several days before and after the culminating day of the freshet, it will be seen readily how much delay was occasioned by this cause. This was further intensified by the position of the dredged channels which are particularly exposed during swift currents. The following is a summary of the cubic yards excavated.

Date.	Sand and gravel.	Rock.		Total.
		Disintegrated.	Solid.	
1889.				
July		2,375.2	513.0	2,888.2
August		865.9	188.0	1,053.9
September	1,212.8			1,212.8
October		2,117.1	401.0	2,518.1
November		899.7	286.0	1,185.7
Total	1,212.8	6,257.9	1,388.0	8,858.7

DUTCH GAP EXCAVATION.

The work of excavation was rendered necessary here by a land-slide which was described in the last annual report. The work to be done consisted in dredging a channel in behind the slide, so as to cut off all outward pressure and thus prevent any further sliding into the Gap itself. It was deemed more judicious to follow this plan than to attempt to cut off the toe of the slide; this method also gave an opportunity for the freshet to act upon the material, and to wash it into the deep holes below, which, however, it does not appear to have done to any considerable extent.

The work was completed on the 9th of September, when a total (including last year's amount) of 39,725.9 cubic yards were removed; a channel 60 feet wide and 7 feet deep at low tide was cut entirely through. The island thus left in the Gap should be entirely removed at as early a day as possible. The following is a summary of the work:

	Cubic yards.
July	8,207.8
August	7,171.8
September	1,782.5
Total	17,162.1

DUTCH GAP TRAINING-WALLS.

Owing to the cutting through of the Gap and the great change created thereby in the force and direction of the currents of the river, certain slow physical changes have been taking place which need careful watching lest they produce injury to the channels.

Among these changes is a gradual eating away of the shore to the east of the Gap, on the right bank of the river. This for several years past has been assuming a greater and greater degree of importance, and it was decided to prevent any further encroachment by a brush training-wall. This work was advertised for contract, and let to A. J. Bradley, esq., who commenced on the 4th of September, 1889, and completed on the 9th of December, having constructed during that time 4,264 linear feet. As far as known it has answered its purpose thoroughly. It was executed as follows:

	Linear feet.
September	1,045
October	1,834
November	492
December	893
Total	4,264

GOODE'S ROCKS.

This work was also a continuation of the work of the last fiscal year. It was prosecuted during July and August and was completed August 31, 1889. The following is a summary of the work done:

Month.	Holes drilled.	Linear feet drilled.	Rock.	
			Disintegrated.	Solid.
			Cub. yds.	*Cub. yds.*
July	117	802	90.6	370.7
August	72	430	264.5	633.4
Total	189	1,232	355.1	1,064.1

A channel 30 feet wide and 22 feet deep at low tide is to be dredged without drilling and blasting. To cut through this has been several years' work. The cut has been advanced about 500 feet by this work. It is somewhat remarkable that the cut should not have been filled by the sand, but it has not done so to any extent. The sand appears to sweep through the cut at times, during which it seriously obstructs the drilling by choking the drill, but it does not lodge in the cut.

KINGSLAND REACH.

The numerous and high freshets had the effect of producing a short but very obstructive shoal at Kingsland Reach. This locality of the river has been so well described in previous reports that any repetition of its particular features is unnecessary. It has been demonstrated, beyond all doubt, that any dredging done would simply be a temporary relief, unless at the same time some works of alignment were built. That a proper alignment of the river here is of the utmost importance, is shown, not only by theory but by the following practice. For the reach was dredged out in 1878 and 1887, and yet in October, 1889, the bar had precisely the same depth as when the dredging was first begun. The alignment necessary had been calculated from the figures of the different surveys, and consisted of two parts, a high training-wall (8 feet above high tide) on the right bank, and a low training-wall (high tide) on the left bank. It was decided to construct the training-wall on the right bank, and at the same time to dredge a channel through the shoal. Proposals were, therefore, invited for the construction of the training-wall and for dredging. Those for dredging were all considered too high, the lowest being 18 cents per cubic yard, and an agreement was entered into with Messrs. Gunn & Co. to do the excavation at 14 cents per cubic yard. The excavation was begun on the 11th of November, 1889, and was prosecuted satisfactorily to its completion on the 22d of March, 1890. During this time 59,960.9 cubic yards of sand and some muckage were removed as follows:

	Cubic yards.
November	8,223.5
December	8,779.8
January	22,957.0
February	10,006.0
March	9,994.6
Total	59,960.9

The excavation of this material opened a channel 100 feet wide and 16 feet deep at low water through the shoal. In many places the sand ran directly back into the cut, but as it was dug much deeper than 16 feet the result was that at many points the resulting channel is much wider. The running in of the light sand has always occurred here. The proposal of Mr. W. T. Gaynor for the training-wall was accepted. Work was begun by him on the 18th of November, 1889, and was continued through to completion on the 10th of January, 1890. A total of 5,075.5 linear feet was constructed as follows:

	Linear feet.
November	1,005.5
December	2,873.8
January	1,196.2
Total	5,075.5

Part of this structure is parallel to the direction of the current, *i. e.*, training-wall, and part is at right angles, *i. e.*, wing-dam. As far as known the structure is doing what was expected of it. However, only one slight freshet has occurred since its completion, and this is too limited an experience from which to draw a general conclusion.

PLANT.

To aid and expedite the work on the river the construction of one scow and one combined steam hoister and pile-driver were undertaken. Proposals were invited for these, and the bids of Brusstar & Co. for the scow and H. T. Morison & Co. for the hoister were accepted. Both vessels were completed according to their respective contracts. The hoister has given great satisfaction in its workings as a pile driver.

STANDARD SURVEY.

In addition to the usual surveys that have been made annually, in order to determine the effect of the works of contraction, a standard survey was begun in December and was continued until the 1st of March. The section composed in this survey was from Dutch Gap to Jordan's Point. The object of this survey was to obtain soundings sufficiently near together, and on proper lines, so that the physical characteristics of the various sections might be determined. The maps resulting from these surveys have all been plotted and traced. From these maps about four hundred sections have been selected, in which are formulated the low-tide area, the high-tide area, the maximum and mean depth, the position of the center of area, the width and the tidal vol-

ume in between sections. From these sections are to be calculated and plotted the causes of alignment to which the river shores will be reduced. From the rectified position of the shores the port-warden lines will be established.

NAVIGABLE CONDITION OF THE RIVER.

Notwithstanding the many high freshets that have occurred during the past eighteen months the river as far as known is in a better condition than before in those reaches where the works of contraction have been put in. There are some points that have not been touched for a period of ten years and yet the channel is as good, in most instances a great deal better, than when they were last worked upon, thus demonstrating the lasting effect of the works of the improvement. As the work of the last fiscal year was but a continuation of the work of the previous year no greater navigable depth can be reported, as the intervening bars have not been worked upon. The following is the practical available draught at high tide: from the sea to Center's Neck, 19½ feet, thence to Goode's Rock, 18 feet; thence to Richmond, 16½ feet.

Very respectfully, your obedient servant,

C. P. E. BURGWYN.

Col. WM. P. CRAIGHILL,
Corps of Engineers, U. S. A.

Section.	Rise and fall of tide.	Area in square feet.		Distance of center of area from right bank.	Depth of water at low tide.		Width.	Deflection of curve of center of area.	Distance to next section.	Tidal volume between sections.
		High tide.	Low tide.		Max.	Mean				
								° ′		
B to dike[1]	3.5	5,393	4,137	189	17.3	11.2	371	.....	405	481,950
A to dike	3.5	5,378	4,255	192	17.5	11.2	378	.....	390	492,180
1 to dike	3.5	5,836	4,436	198	17	11	403	0 30 L	410	578,510
3 to dike	3.5	6,229	4,807	213	17.1	11.1	435	2 15 R	400	583,200
5 to dike	3.5	6,301	4,908	216	17.3	12.4	398	0 30 R	420	647,220
7 to dike	3.5	6,760	5,171	218	17.2	11.4	451	5 00 R	410	563,340
9 to dike	3.5	5,896	4,738	191	17.9	14.3	331	4 00 L	395	537,575
11 to dike[2]	3.5	7,475	5,912	225	17.3	14.1	418	6 15 R	385	604,065
13 to dike	3.5	7,995	6,420	244	17.8	14.3	450	5 15 R	440	677,600
15 to dike	3.5	7,506	6,091	237	16.8	14.2	430	5 15 R	335	512,550
17 to dike	3.5	7,596	6,042	214	16.8	12.5	484	1 00 R	375	582,750
19 to dike	3.5	7,516	5,952	213	20.3	13.1	447	6 15 R	445	731,125
21 to dike[3]	3.5	7,446	5,724	215	17.8	11.6	492	6 15 R	410	690,440
23 to dike	3.5	6,716	5,071	182	19.3	10.7	470	2 45 L	405	596,970
25 to dike	3.5	6,676	5,374	192	17.8	11	395	2 15 L	385	584,815
27 to dike	3.5	7,219	5,483	201	16.4	11	496	0 30 R	320	529,920
29 to dike	3.5	7,344	5,769	214	17.6	12.8	450	11 30 L	260	423,280
31 to dike[4]	3.5	7,876	6,196	228	20.1	12.9	480	8 00 L	395	635,950
33 to 24	3.5	8,050	6,510	195	21	14.8	440	12 45 L	505	751,440
Dike to 26	3.5	8,248	6,813	198	21.4	16.6	418	9 30 L	480	679,680
Dike to 28	3.5	6,888	5,492	192	22.5	13.9	396	9 00 L	325	477,100
Dike to 28½	3.5	6,655	5,115	241	20.4	11.8	440	7 00 R	325	494,978
35 to 30	3.5	6,794	5,289	234	17.8	12.3	430	4 45 R	615	915,735

[1] Brewery. [2] C. and O. Wharves. [3] Stearn's Dike. [4] Goode's Rock.

Available draught at high tide—Continued.

Section.	Rise and fall of tide.	Area in square feet.		Distance of center of area from right bank.	Depth of water at low tide.		Width.	Deflection of curve of center of area.	Distance to next section.	Tidal volume between sections.
		High tide.	Low tide.		Max.	Mean.				
								° ′		
Dike to 32	3.5	7,047	5,574	232	16.8	13.2	421	2 45 R	525	785,400
Dike to 34	3.5	7,339	5,820	235	15.5	13.4	434	2 15 R	510	781,830
Dike to 36[1]	3.5	7,472	5,926	223	16.3	13.4	440	0 15 L	400	619,200
37 to 38	3.5	7,684	6,134	220	16.2	13.9	443	2 00 R	375	583,500
39 to 40	3.5	7,801	6,240	214	16.6	13.9	446	3 00 L	270	432,810
Dike to 42	3.5	8,004	6,359	242	17.3	13.5	470	3 15 R	265	423,470
41 to 44	3.5	8,073	6,523	228	16.7	14.5	443	0 15 R	225	358,550
Dike to 46	3.5	8,308	6,663	250	16.4	14.2	470	0 00	210	324,660
43 to 46½	3.5	8,249	6,702	236	17.1	15.1	442	2 45 R	355	538,120
43½ to dike	3.5	8,196	6,656	231	16.6	15.1	440	1 00 L	380	599,500
45 to dike	3.5	8,121	6,511	232	17.6	14.2	460	3 15 R	480	737,760
47 to 48	3.5	7,438	5,975	216	16.2	14.3	418	1 00 R	475	686,850
49 to 50	3.5	7,495	6,067	202	17.6	14.8	408	2 00 L	445	641,680
51 to 52[2]	3.5	7,667	6,211	204	17.4	14.9	416	2 00 R	485	702,765
53 to 54	3.5	8,221	6,779	190	22.4	16.4	412	3 45 L	380	547,960
55 to 56	3.5	8,625	7,163	194	21.6	17.4	412	2 15 L	415	597,185
57 to 58	3.5	8,781	7,346	194	21.1	17.9	410	1 30 R	315	453,600
59 to 60	3.5	8,434	7,010	185	20.5	17.2	407	3 15 L	270	393,390
61 to 62	3.5	8,707	7,237	186	21.3	17.2	420	5 15 L	455	661,570
63 to 64	3.5	7,998	6,560	194	19	15.9	411	1 00 R	495	719,730
65 to 66	3.5	8,731	7,261	199	22.4	17.3	420	5 15 L	510	768,570
67 to 68	3.5	8,844	6,801	230	18.2	15.4	441	0 15 R	495	762,300
69 to 70	3.5	8,934	7,398	225	21	16.8	439	0 15 L	445	680,405
71 to 72	3.5	9,113	7,591	223	21.7	17.4	435	1 30 L	470	716,230
73 to 74	3.5	9,309	7,783	230	20.1	17.8	436	0 15 R	485	744,475
75 to 76	3.5	9,452	7,909	237	20.6	17.9	441	2 00 R	505	781,225
77 to 78	3.5	9,744	8,194	232	20.4	18.5	443	1 30 L	495	751,730
79 to 80	3.5	9,630	8,080	236	22.4	18.2	443	2 30 L	510	791,530
81 to 82	3.5	10,461	8,907	264	22	20	444	8 15 R	465	735,630
83 to 84[3]	3.5	9,909	8,299	236	22	18	460	1 00 L	535	859,745
85 to 86	3.5	9,241	7,637	247	21.4	16.6	460	0 30 L	520	853,840
87 to 88	3.5	9,256	7,576	269	21.3	15.7	480	8 30 R	520	882,900
89 to 90	3.5	9,218	7,503	256	19.3	15.3	490	0 15 L	530	890,400
91 to 92	3.5	8,637	6,992	251	19.9	14.9	470	0 00	370	634,550
93 to 94	3.5	9,965	8,180	285	21.1	16	510	6 00 R	385	673,750
95 to 96	3.5	10,029	8,314	279	23.6	16.9	490	4 00 R	525	928,725

[1] Richmond Bar. [2] Randolph Flats. [3] Warwick Bar.

Available draught at high tide—Continued.

Section.	Rise and fall of tide.	Area in square feet.		Distance of center of area from right bank.	Depth of water at low tide.		Width.	Deflection of curve of center of area.	Distance to next section.	Tidal volume between sections.
		High tide.	Low tide.		Max.	Mean.				
								° ′		
97 to shore	3.5	9,872	8,049	268	21.8	15.4	521	1 45 R	485	917,620
99 to shore	3.5	9,813	7,853	270	20	14	560	5 30 R	500	963,500
101 to shore	3.5	10,081	8,188	266	22.4	15.1	541	3 00 R	490	915,810
103 to shore	3.5	10,674	8,830	288	24.3	16.7	527	4 15 R	460	867,100
105 to shore	3.5	10,701	8,776	300	21.4	15.9	550	1 00 R	500	968,000
107 to shore	3.5	10,535	9,589	297	19.7	15.4	556	2 30 R	485	954,450
109 to shore	3.5	11,149	9,159	281	19.6	15.6	584	3 45 R	520	1,040,000
111 to shore	3.5	11,280	9,271	287	18.4	16.1	574	2 00 R	500	980,000
113 to shore	3.5	11,616	9,705	260	21.1	17.6	546	3 00 L	485	952,600
115 to shore	3.5	11,464	9,455	259	20.8	16.4	574	0.45 L	355	741,950
117 to shore	3.5	12,021	9,851	265	21.4	15.9	620	0 45 L	345	779,010
119 to shore[1]	3.5	12,758	10,413	276	22.4	15.5	670	5 45 L	485	1,222,200
123 to shore	3.5	12,877.5	10,182.5	316	24.9	13.2	770	.....	445	1,213,070
127 to shore	3.5	11,486.5	8,789.5	258	22.3	11.4	770	.....	445	1,205,505
131 to shore	3.5	11,290.5	8,630.5	254	23.3	11.3	760	.....	240	630,720
133 to shore	3.5	10,841.5	8,246.5	254	24	10.7	770	.....	495	1,257,300
137 to shore	3.5	10,207.5	7,722.5	220	25.2	10.9	710	.....	495	1,221,600
Shore to 142	3.5	10,224	7,774	185	29.5	11.1	700	.....	575	1,408,750
Shore to 146	3.5	11,455	9,005	226	26.9	12.8	700	.....	560	1,342,880
Shore to 150	3.5	11,431.5	9,086.5	216	25.6	13.6	670	.....	160	366,080
No. 1[2]	.....	11,973.5	9,743.5	212	28.5	14.7	660	.....	303	651,450
No. 2	.....	10,703	8,633	190	29.9	14.3	690	4 45 L	292	605,608
No. 3	.....	10,372.5	8,293.5	182	29.8	13.8	600	8 00 L	292	558,888
No. 4	.....	10,982	9,134	187	28.6	17.2	530	3 30 L	248	432,752
No. 5	.....	9,845	8,096	191	29.6	16.2	500	1 15 R	230	406,180
No. 6	.....	10,396.5	8,614.5	216	28.5	17	510	2 00 L	295	529,705
No. 7[3]	.....	11,087.5	9,272.5	220	26.6	17.8	520	8 30 L	270	512,460
No. 8	.....	10,899	8,919	243	26	15.6	570	5 30 L	330	682,440
No. 9	.....	11,641	9,496	280	24.9	15.3	620	10 30 L	280	566,720
No. 10	.....	10,896.5	8,994.5	263	29.8	15.9	560	5 00 L	310	591,480
No. 11	3.5	10,559.6	8,645.6	249	29.5	15.7	550	8 00 L	190	351,120
No. 12	3.5	11,003.5	9,221.5	236	29.2	18	510	7 30 R	320	549,120
No. 13[4]	3.5	10,613	8,963	219	26.7	19	470	8 30 L	290	483,430
No. 14	3.5	10,454.5	8,771.5	235	27.5	18.2	480	10 00 R	310	572,880
No. 15	3.5	12,823	10,810	247	28.5	18.6	580	14 50 L	310	613,800
No. 16[5]	3.5	11,438	9,491	229	27.4	16.9	560	2 00 L	295	576,350

[1] Falling Creek.
[2] Drewry's Bluff.
[3] Transit station, Drewry's.
[4] Transit station, Cornwall.
[5] Transit station Box.

Available draught at high tide—Continued.

Section.	Rise and fall of tide.	Area in square feet.		Distance of center of area from right bank.	Depth of water at low tide.		Width.	Deflection of curve of center of area.	Distance to next section.	Tidal volume between sections.
		High tide.	Low tide.		Max.	Mean.		° ′		
No. 17	3 5	11,628	9,648	246	26.3	17	570	10 00 L	260	519,220
No. 18	3.5	10,784.5	8,771.5	246	23.8	16.8	580	10 15 R	245	501,270
No. 19[1]	3.5	10,828	8,749	273	22.4	14.5	600	4 45 L	295	623,040
No. 20	3.5	11,150.5	9,005.5	291	21.1	14.5	620	2 00 R	280	600,610
No. 21[2]	3.5	11,011	8,866	328	20.7	14.3	620	4 00 R	275	603,625
No. 22	3.5	11,214	8,970	328	20.6	13.8	650	3 15 R	270	605,880
No. 23	3.5	11,969.5	9,695.5	329	19.7	14.9	650	0 30 R	320	734,080
No. 24	3.5	11,696	9,353	374	17.3	13.8	680	10 00 R	295	691,185
No. 25	3.5	11,425.5	9,082.5	411	22.9	13.3	680	7 00 R	360	855,360
No. 26[3]	3.5	12,361	9,952	463	30.5	14.2	700	15 15 R	275	667,150
No. 27	3.5	11,887	9,445	481	32.4	13.2	710	12 15 R	250	594,000
No. 28	3.5	11,878.5	9,568.5	450	39.1	14.2	670	3 00 L	210	471,240
No. 29	3.5	11,929	9,751	430	39.8	15.4	630	8 15 R	250	536,250
No. 30	3.5	13,241	11,129	387	37.8	18.4	610	12 30 R	305	613,965
No. 31	3.5	12,462	10,548	337	38.8	19.2	550	8 45 R	280	466,760
No. 32[4]	3.5	11,023	9,604	204	35.7	24	400	7 15 R	185	287,120
No. 33	3.5	11,860	10,276	220	33.8	22.8	450	0 30 L	265	433,010
No. 34	3.5	11,923	10,240	251	33.8	21.3	480	5 00 R	305	548,630
No. 35	3.5	11,606	9,857	272	27.8	19.7	500	1 30 R	275	491,725
No. 36	3.5	11,517.5	9,669.5	297	28.8	18.2	530	3 00 R	270	507,870
No. 37	3.5	11,434.5	9,520.5	295	25.4	17.3	550	6 30 L	180	456,400
No. 38	3.5	12,237.5	10,191.5	327	24.6	17.2	590	12 15 L	305	613,965
No. 39	3.5	11,314	9,334	347	24.5	16.3	570	2 45 R	235	449,790
No. 40	3.5	10,432.5	8,584.5	292	25	16.2	530	2 15 L	285	550,335
No. 41[5]	3.5	11,701	9,688	333	25.6	16.7	580	9 30 R	310	629,300
No. 42[6]	3.5	11,702.5	9,656.5	337	23.5	16.3	590	3 15 L	225	456,750
No. 43	3.5	12,013	10,000	328	22.3	16.4	610	2 45 L	300	603,900
No. 44	3.5	11,238	9,225	343	21.7	15.1	610	3 30 R	325	634,400
No. 45	3.5	11,331	9,441	331	20.1	15.7	600	3 45 R	285	589,095
No. 46	3.5	11,711.5	9,467.5	333	19.5	14.5	650	1 45 L	280	656,040
No. 47	3.5	11,789	9,347	379	19.2	13.1	710	4 30 R	265	638,385
No. 48	3.5	11,205.5	8,829.5	366	19.2	12.8	690	0 00	295	700,820
No. 49	3.5	11,861.5	9,485.5	355	18.0	13.7	690	9 00 L	280	660,800
No. 50	3.5	11,926.5	9,583.5	393	22.7	14.1	680	3 00 R	260	557,760
No. 51	3.5	12,378	10,431	422	20.7	13.7	560	7 30 R	295	667,260
No. 52	3.5	12,694.5	10,186.5	368	18.5	13.9	730	14 30 L	260	636,340

[1] Transit station, Wilton.
[2] Transit station, Stone.
[3] Transit station, Kiln, Chaffin Bluff.
[4] Transit station, Bluff, Chaffin Bay.
[5] Transit station, Battle.
[6] Transit station, Birch.

Available draught at high tide—Continued.

Section.	Rise and fall of tide.	Area in square feet.		Distance of center of area from right bank.	Depth of water at low tide.		Width.	Deflection of curve of center of area.	Distance to next section.	Tidal volume between sections.
		High tide.	Low tide.		Max.	Mean.				
								° ′		
No. 53[1]	3.3	12,002.5	9,692.5	334	17.6	14.4	670	13 30 R	250	610,500
No. 55	3.3	13,517	10,943	378	18.5	14.6	750	4 00 L	285	752,400
No. 56	3.3	14,054.5	11,348.5	372	19.5	14.3	790	7 30 L	275	740,750
No. 57	3.3	13,464	10,791	325	21.7	13.8	780	8 30 L	270	710,660
No. 58[2]	3.3	13,093.5	10,651.5	293	29.3	15	710	8 00 L	295	691,185
No. 59	3.3	12,308	10,064	258	30.2	15.5	650	1 30 L	235	515,825
No. 60[3]	3.3	12,013.5	9,868.5	242	29	15.9	620	5 30 L	250	528,000
No. 61	3.3	11,579.5	9,500.5	236	27	15.8	600	2 00 R	230	479,320
No. 62	3.3	10,590	8,511	201	24.4	14.2	600	26 45 L	255	527,340
No. 63	3.3	10,743	8,697	253	21.3	14.7	590	13 00 R	200	412,600
No. 64	3.3	10,834	8,755	279	26	14.6	600	27 30 L	210	440,160
No. 65[4]	3.3	11,367	9,256	251	18.7	15.1	610	24 30 R	165	345,840
No. 66	3.3	9,965.5	7,896.5	358	18.5	13.1	600	7 00 L	215	471,925
No. 67[5]	3.3	9,374.5	7,564.5	365	17.4	11.2	670	2 30 L	265	625,400
No. 68	3.3	9,862	7,453	393	18.5	10.6	700	13 00 R	295	709,920
No. 69[6]	3.3	10,298.5	7,955.5	365	16.9	11.7	680	5 15 R	260	596,440
No. 70	3.3	10,865.5	8,621.5	313	19.3	13.2	650	7 30 L	250	569,250
No. 71	3.3	11,462.5	9,152.5	323	22.2	13.7	670	18 00 R	255	576,555
No. 72	3.3	10,469.5	8,258.5	291	17.8	12.9	640	1 15 L	255	559,725
No. 73[7]	3.3	12,606.5	10,428.5	289	29.2	14.9	630	9 45 R	265	585,915
No. 74[8]	3.3	15,627.5	13,383.5	280	34.6	20.5	650	2 30 L	275	598,940
No. 75	3.3	17,631	15,519	297	41.5	25.4	610	10 00 R	215	418,605
No. 76[9]	3.3	16,637.5	14,855.5	296	56.4	29.1	510	15 00 R	160	290,400
No. 77	3.3	16,451.5	14,603.5	282	51.5	27.5	530	15 00 R	225	423,050
No. 78[10]	3.3	14,328.5	12,381.5	298	43.4	22.1	560	4 15 R	325	659,750
No. 79	3.3	13,602.5	11,490.5	282	34.8	18.8	610	14 30 R	310	675,180
No. 80[11]	3.3	12,801.5	10,557.5	302	28.6	16.2	650	6 15 R	255	557,685
No. 81	3.3	12,656	10,526	298	28.2	15.5	680	14 30 L	275	630,550
No. 82	3.3	13,377.5	10,935.5	333	22.9	15.4	710	0 00	245	626,710
No. 83	3.3	13,763	11,090	373	22	14.2	780	0 00	310	844,130
No. 84[12]	3.3	12,845	10,073	372	20.3	12.4	810	2 00 L	330	925,650
No. 85	3.3	13,445	10,607	350	19.6	12.7	830	4 30 L	255	715,275
No. 86	3.3	13,571.5	10,799.5	351	20.5	13.3	810	1 45 L	245	687,025
No. 87	3.3	14,398	11,560	360	21.5	13.9	830	2 15 L	240	637,680

[1] Transit station, Willis' Wharf.
[2] Transit station, Kingsland.
[3] Transit station, Ged.
[4] Transit station, Out.
[5] Transit station, Inlet.
[6] Transit station, Nick.
[7] Transit station, Bain.
[8] Transit station, Phil.
[9] Transit station, Bennett's Wharf.
[10] Transit station, Aground.
[11] Transit station, Dam.
[12] Transit station, Trunk.

Available draught at high tide—Continued.

Section.	Rise and fall of tide.	Area in square feet.		Distance of center of area from right bank.	Depth of water at low tide.		Width.	Deflection of curve of center of area.	Distance to next section.	Tidal volume between sections.
		High tide.	Low tide.		Max.	Mean.				
								° ′		
No. 88	3.3	14,164.5	11,689.5	295	21.5	16.2	720	4 45 L	250	660,000
No. 89[1]	3.3	16,003.5	13,198.5	304	33.5	16.1	820	5 30 L	270	663,930
No. 90	3.3	14,729.5	12,617.5	217	40.6	20.6	610	22 00 L	315	618,660
No. 91	3.3	14,872	13,057	214	48.6	25.1	520	9 15 L	280	489,720
No. 92[2]	3.3	14,701	13,018	216	50.7	27.1	480	13 15 L	260	429,600
No. 93	3.3	15,554.5	13,937.5	238	49.8	30.3	460	9 15 L	230	364,320
No. 94	3.3	13,191.5	11,640.5	225	43.9	26.4	440	1 45 R	255	399,840
No. 95[3]	3.3	14,782	13,198	213.5	43.4	29.3	450	9 30 L	290	483,430
No. 96[4]	3.3	15,328	13,579	229	39.4	27.1	560	10 30 L	215	378,680
No. 97	3.3	13,263	11,481	246	37.6	22.7	510	1 45 L	310	567,920
No. 98	3.3	14,175	12,294	251	34.2	22.7	540	1 00 L	255	492,465
No. 99	3.3	14,010.5	12,030.5	256	30.9	21.1	570	11 00 L	290	533,340
No. 100	3.3	13,933	11,821	271	28.1	19.3	610	9 15 L	310	634,260
No. 101[5]	3.3	14,677	12,697	206	51.3	22.2	570	20 15 L	365	740,950
No. 102	3.3	20,312	18,233	283	59.6	30.4	600	8 30 L	160	345,920
No. 103	3.3	24,098.5	21,854.5	319	65.2	33.6	650	34 30 L	195	415,155
No. 104	3.3	14,734	12,721	302	38.3	23.7	580	6 45 L	320	623,040
No. 105[6]	3.3	13,799	11,918	307	35.4	22	540	.....	285	526,680
No. 106	3.3	12,642	10,827	284	36.8	20.8	520	3 00 L	280	498,960
No. 107[7]	3.3	12,887.5	11,138.5	230	36.8	22.2	500	4 30 R	295	496,485
No. 108	3.3	13,654.5	11,437.5	217	39.1	24.9	460	3 00 R	250	404,250
No. 109	3.3	14,151	12,534	220	41.3	27.2	460	6 00 R	270	456,660
No. 110	3.3	14,266	12,550	253	42.9	27.6	490	15 15 R	300	529,800
No. 111[8]	3.3	14,664	12,849	293	42.8	24.7	520	12 30 R	255	471,240
No. 112	3.3	14,837	12,956	339	46.3	23.9	540	16 30 R	285	569,145
No. 113	3.3	14,552	12,539	340	37.2	21.6	580	18 30 R	235	484,885
No. 114	3.3	13,421	11,309	317	34.1	18.5	610	2 00 L	245	521,605
No. 115[9]	3.3	13,899	11,754	323	30.9	18.9	620	10 45 R	295	633,040
No. 116[10]	3.3	13,119.5	11,040.5	312	37.6	18.4	600	9 45 R	365	722,700
No. 117	3.3	13,201.5	11,320.5	305	39.5	20.9	540	9 00 R	300	769,400
No. 118	3.3	12,826	10,912	306	36.4	19.8	550	1 30 R	295	5699,10
No. 119	3.3	12,636	10,755	318	36.3	19.9	540	5 30 R	295	554,895
No. 120	3.3	12,714.5	10,833.5	305	33.2	20.0	540	6 00 R	265	498,465
No. 121[11]	3.3	12,330.5	10,449.5	302	31.1	19.3	540	6 45 R	260	502,000

[1] Transit station, ferry.
[2] Transit station, Cave Devil's Reach.
[3] Transit station, Pierce.
[4] Transit station, Sycamore.
[5] Transit station, Pine Devil's Reach.
[6] Transit station, Point.
[7] Transit station, House.
[8] Transit station, Duval.
[9] Transit station, Vale.
[10] Transit station, Meadow.
[11] Transit station, Raspberry.

Available draught at high tide—Continued.

Section.	Rise and fall of tide.	Area in square feet.		Distance of center of area from right bank.	Depth of water at low tide.		Width.	Deflection of curve of center of area.	Distance to next section.	Tidal volume between sections.
		High tide.	Low tide.		Max.	Mean.				
								° ′		
No. 122	3.3	12,509	10,529	303	30.0	18.4	570	2 15 L	260	497,640
No. 123	3.3	12,050.5	10,182.5	282	27.5	19.2	530	3 15 R	220	406,780
No. 124	3.3	12,255	10,407	298	28.4	19.8	550	3 30 L	280	563,640
No. 125	3.3	13,611	11,433	356	28.3	18.1	630	8 30 R	250	557,000
No. 126	3.3	13,747	11,470	391	28.7	17.3	660	6 00 R	260	583,440
No. 127	3.3	13,730	11,519	384	29.9	18	640	13 30 R	250	540,500
No. 128	3.3	12,937.5	10,825.5	366	32.3	17.7	610	2 45 R	220	457,380
No. 129	3.3	13,068.5	11,022.5	360	33.5	18.7	580	2 00 L	260	514,800
No. 130	3.3	11,962.5	10,048.5	348	36	18.2	550	2 45 R	225	438,075
No. 131	3.3	12,763.5	10,783.5	348	37	18.9	570	4 45 R	235	449,790
No. 132[1]	3.3	12,792.5	10,944.5	339	35	20.6	530	.....	80	155,760
No. 133	3.3	13,300.5	11,254.5	365	34.3	19.1	590	11 30 R	315	618,670
No. 134	3.3	11,821	9,940	321	32.7	18.4	540	9 45 R	305	558,760
No. 135	3.3	12,487	10,705	296	32.9	20.9	510	11 30 R	325	566,425
No. 136	3.3	12,258	10,542	262	35.4	21.5	490	3 45 R	230	506,180
No. 137	3.3	11,593	9,778	270	35.1	18.8	520	6 30 R	250	433,250
No. 138[2]	3.3	12,191	10,541	256	35.1	22.4	470	7 15 R	215	401,190
No. 139	3.3	12,604	10,522	272	36.2	20.6	510	.....	295	565,220
No. 140	3.3	13,088	81,339	300	35.4	22.6	500	6 00 R	315	571,725
No. 141	3.3	13,676.5	11,795.5	309	36	21.8	540	8 45 R	360	689,040
No. 142	3.3	12,975	11,028	301	36.1	19.7	560	8 00 R	145	287,100
No. 143[3]	3.3	14,342	12,329	286	33.3	21.2	580	.....	1,380	3,708,060
No. 144[4]	3.2	28,681	25,321	636	50.4	24.8	1,020	.....	285	921,120
No. 145[5]	3.2	19,318.5	16,124.5	487	41.5	17.2	940	29 30 L	325	962,000
No. 146	3.2	20,148	17,332	443	38	20.4	850	1 15 L	310	848,160
No. 147	3.2	18,636	15,980	427	35.1	19.9	800	3 30 L	255	636,480
No. 148	3.2	15,930	13,934	417	32.7	19.4	700	17 00 R	295	670,240
No. 149	3.2	17,046.5	14,838.5	373	39.2	22.4	660	4 30 R	250	520,000
No. 150	3.2	18,733	16,781	291	43.3	28.9	580	4 15 L	170	320,960
No. 151	3.2	19,241.5	17,417.5	278	43.6	32.2	540	9 30 R	265	479,120
No. 152	3.2	18,361	16,569	279	43.6	31.2	530	2 30 R	240	437,760
No. 153[6]	3.2	15,568.5	13,712.5	319	42.7	24.9	550	12 15 R	205	387,040
No. 154	3.2	16 870	14,950	318	40.1	26.2	570	4 00 R	365	718,220
No. 155	3.2	16,537.5	14,521.5	308	38.2	24.2	600	3 30 L	255	526,320
No. 156	3.2	16,754.5	14,642.5	340	34.1	23.2	630	8 30 R	225	482,400
No. 157	3.2	17,618	15,442	351	33	23.7	650	3 30 L	275	611,000

[1] Transit station, Cox's Wharf.
[2] Transit station, Friend.
[3] Transit station, Bar, Upper Dutch G.
[4] Transit station, Lower Dutch G.
[5] Transit station, View East.
[6] Transit station, Line.

Available draught at high tide—Continued.

Section.	Rise and fall of tide.	Area in square feet.		Distance of center of area from right bank.	Depth of water at low tide.		Width.	Deflection of curve of center of area.	Distance to next section.	Tidal volume between sections.
		High tide.	Low tide.		Max.	Mean.		° ′		
No. 158	3.2	16,954	14,682	393	31.9	21.6	680	4 00 L	230	540,960
No. 159	3.2	17,770	15,338	439	29.0	20.1	730	10 30 R	225	554,400
No. 160	3.2	17,015	14,519	450	28.5	19.3	750	2 45 R	245	638,960
No. 161	3.2	18,173	15,453	473	26.7	18.8	820	0.00	260	711,360
No. 162	3.2	18,003	15,251	467	26.3	18.3	830	5 45 L	260	702,520
No. 163	3.2	17,673	15,021	480	25.6	18.1	830	4 15 R	235	642,490
No. 164[1]	3.2	17,262.5	14,546.5	504	24.9	16.9	850	7 45 R	215	605,440
No. 165	3.2	16,466	13,650	480	23.3	16	850	6 15 L	240	675,840
No. 166	3.2	16,987.5	14,171.5	491	21.8	16.6	850	12 00 L	240	691,440
No. 167	3.2	17,913	14,967	534	20.6	16.8	890	20 45 R	305	912,965
No. 168	3.2	17,564	14,524	524	20	15.7	920	9 45 L	235	721,920
No. 169[2]	3.2	17.503	14,399	516	18.5	15.3	940	3 00 R	270	868,320
No. 170	3.2	17,923.5	14,595.5	539	18	14.4	1,010	0 45 L	295	986,480
No. 171	3.2	18,520	15,160	564	17.6	14.8	1,020	0 00 R	305	1,058,980
No. 172	3.2	18,518	14,984	558	17.2	13.1	1,090	14 00 R	165	562,650
No. 173[3]	3.2	18,108.5	14,872.5	512	17.3	14.8	1,000	4 15 L	285	953,610
No. 174	3.2	17,517	14,061	503	17	13.4	1,050	8 00 L	245	776,160
No. 175	3.2	16,776	13,896	479	18.8	15.9	870	12 15 L	255	807,840
No. 176	3.2	20,453.5	16,997.5	532	22.6	16.2	1,050	16 15 R	245	777,875
No. 177[4]	3.2	19,166.5	16,272.5	481	21.7	18.2	896	5 15 L	345	1,061,015
No. 178	3.2	18,994.5	15,794.5	429	20.8	16.3	970	8 00 L	290	932,640
No. 179	3.2	18,996	15,766	424	24.2	16.1	980	2 30 L	405	1,283,040
No. 180	3.2	18,369.5	15,265.5	403	24.4	16.2	940	17 15 L	250	820,000
No. 181	3.2	19,903.5	16,447.5	402	27.3	15.6	1,050	8 45 R	305	1,005,280
No. 182[5]	3.2	18,136	15,000	360	31.4	15.8	950	23 30 L	120	376,320
No. 183	3.2	17,875	14,239	385	29.8	14.9	950	26 30 R	295	925,120
No. 184	3.2	17,454.5	14,318.5	335	23	15	950	6 30 L	305	956,440
No. 185	3.2	18,278.5	15,142.5	329	32.1	15.9	950	11 45 L	345	1,065,360
No. 186	3.2	17,136.5	14,096.5	330	32.2	15.3	920	00 00	345	1,076,400
No. 187	3.2	18,954	15,754	323	33.3	16.2	970	4 00 L	315	1,028,240
No. 188	3.2	19,193	15,801	327	34.9	15.3	1,030	1 00 L	325	1,080,800
No. 189[6]	3.2	17,749.5	14,613.5	269	36.8	15.3	950	16 15 L	205	618,920
No. 190	3.2	18,751	15,839	226	40.3	17.9	880	00 00	375	857,250
No. 191	3.2	16,661	14,941	266	40.7	18.6	800	86 30 L	340	597,720

[1] Transit station, Post.
[2] Transit station, Varina Wharf.
[3] Transit station, Allen.
[4] Transit station, Caldwell.
[5] Transit station Dorchester, Barney's Wharf.
[6] Transit station, Elm.

Available draught at high tide—Continued.

Section.	Rise and fall of tide.	Area in square feet.		Distance of center of area from right bank.	Depth of water at low tide.		Width.	Deflection of curve of center of area.	Distance to next section.	Tidal volume between sections.
		High tide.	Low tide.		Max.	Mean.				
								° ′		
No. 192	3.2	20,050.5	18,194.5	231	60.6	33.1	550	36 30 L	150	266,400
No. 193	3.2	17,552	15,856	231	70.5	31.7	500	84 45 R	165	274,560
No. 194[1]	3.2	19,451	17,819	233	67.5	37.1	480	6 15 R	215	347,440
No. 195[2]	3.2	22,026	20,426	210	64.6	43.4	470	10 15 L	300	471,900
No. 196	3.2	20,662	19,126	211	61.7	42.5	450	7 30 L	205	345,425
No. 197	3.2	20,747	18,923	247	49.8	35	540	9 00 R	390	757,520
No. 198	3.2	20,327	18,215	284	38.9	28.9	630	0 30 L	305	602,960
No. 199	3.2	20,162.5	17,730.5	338	32.9	24.2	730	6 15 R	240	622,080
No. 200	3.2	18,426	15,674	365	28	18.8	830	16 30 L	295	830,720
No. 201[3]	3.2	19,564	16,684	435	25.1	19.2	870	8 30 R	350	1,008,000
No. 202	3.2	18,673.3	15,793	441	23.1	18.1	870	7 30 L	365	1,086,240
No. 203	3.2	18,584	15,512	499	21.3	16.7	930	1 15 L	370	1,160,320
No. 204[4]	3.2	18,563.5	15,363.5	494	20.8	15.8	970	4 00 R	270	909,900
No. 205	3.2	19,016	15,476	571	19.7	14.4	1,070	6 45 L	320	1,160,320
No. 206	3.2	19,003	15,291	601	19.0	13.5	1,130	2 00 R	315	1,188,440
No. 207	3.2	18,597.5	14,757.5	610	19.3	12.6	1,170	6 30 L	335	1,329,280
No. 208	3.2	19,398.5	15,302.5	685	19.4	12.2	1,250	2 15 L	435	1,753,050
No. 209[5]	3.2	18,674.5	14,610.5	939	19.4	11.7	1,240	1 00 R	340	1,398,080
No. 210	3.2	18,476	14,316	680	18.7	11.2	1,270	1 30 L	310	1,269,760
No. 211	3.2	19,298	15,266	678	18.4	12.4	1,230	4 00 R	455	1,967,420
No. 212	3.2	20,095	15,479	572	20.2	14	1,100	0 00	415	1,595,260
No. 213[6]	3.2	18,088	15,016	463	23.8	16.1	930	5 45 R	310	927,520
No. 214[7]	3.2	18,573	15,661	426	26.9	17.9	880	1 45 R	340	947,560
No. 215	3.2	19,376	26,720	372	29.2	20.9	800	9 00 R	380	1,011,040
No. 216	3.2	19,440	16,880	428	29	21.9	770	15 15 R	345	872,160
No. 217	3.2	21,726	19,230	447	37.4	25.6	750	20 00 R	355	834,982
No. 218	3.2	19,442	17,234	406	54.2	26.1	660	2 00 R	285	615,600
No. 219[8]	3.2	18,975	16,863	383	53.6	26.7	630	22 00 R	365	669,440
No. 220	3.2	16,978	15,378	248	50.4	32.7	470	5 45 R	270	373,140
No. 221[9]	3.2	17,710	16,046	254	48.3	32.7	490	2 45 R	305	522,160
No. 222	3.2	16,579	14,819	254	44.2	28.5	520	1 45 R	250	448,000
No. 223[10]	3.2	15,881	14,057	290	42.1	26	540	5 00 R	350	694,400
No. 224	3.2	21,303	19,159	308	44.2	29.9	640	7 15 R	335	686,080
No. 225	3.2	19,994	18,042	283	39.6	31.1	580	2 30 L	290	602,100
No. 226	3.2	19,214	17,028	339	36.9	26.2	650	16 30 R	255	564,570

[1] Transit station, Oak.
[2] Transit station, Sand.
[3] Transit station, Aiken.
[4] Transit station, No. 5.
[5] Transit station, Jetty.
[6] Transit station, Pine.
[7] Transit station, Mud.
[8] Transit station, First.
[9] Transit station, Canal.
[10] Transit station, Deep.

Available draught at high tide—Continued.

Section.	Rise and fall of tide.	Area in square feet.		Distance of center of area from right bank.	Depth of water at low tide.		Width.	Deflection of curve of center of area.	Distance to next section.	Tidal volume between sections.
		High tide.	Low tide.		Max.	Mean.				
								° ′		
No. 227	3.2	19,436	17,196	343	38.6	25.6	670	11 00 R	265	597,840
No. 228[1]	3.2	19,466	17,194	871	41.5	25.2	680	21 15 R	295	656,080
No. 229	3.2	18,693	16,517	347	44.4	25.4	650	15 15 R	250	524,000
No. 230	3.2	17,544	15,528	292	44.3	25.8	600	10 45 L	240	453,120
No. 231[2]	3.2	14,550	12,790	294	42.9	24.6	520	26 45 R	325	592,800
No. 232	3.2	15,408	13,520	241	42	24.1	560	20 45 L	245	450,800
No. 233	3.2	15,626	13,834	256	43.1	26.1	530	10 15 R	260	478,080
No. 234	3.2	15,570	13,746	272	42.1	25.4	540	5 30 R	195	368,160
No. 235	3.2	17,220	15,268	312	42.7	26.8	580	3 30 L	365	734,160
No. 236[3]	3.2	17,663	15,647	333	41.2	24.4	600	4 15 R	350	722,400
No. 237	3.2	16,839	14,727	343	37.4	23.4	630	2 45 R	385	825,440
No. 238	3.2	19,782	17,606	371	39.1	27	650	1 30 R	320	706,560
No. 239	3.2	18,660	16,420	403	39.6	24.5	670	8 15 R	365	852,640
No. 240	3.2	18,397	15,965	435	36.7	21.8	730	1 00 R	360	875,520
No. 241[4]	3.2	18,079	15,647	421	36.7	21.4	730	5 45 R	335	782,560
No. 242	3.2	16,276	14,036	411	36.8	20.9	670	0 45 L	375	816,000
No. 243	3.2	16,124	14,012	383	34.8	22.2	630	4 15 R	550	1,144,000
No. 244	3.2	14,934	12,886	369	34.9	21.1	610	16 45 R	435	967,440
No. 246[5]	3.2	16,543	14,143	441	32	19.6	720	8 00 L	405	1,010,880
No. 247[6]	3.2	18,353	15,761	453	29.5	20.2	780	0 45 R	345	910,800
No. 248	3.2	27,702	15,014	442	27.6	18.5	810	1 15 L	335	896,125
No. 249	3.2	17,857	15,195	480	27.5	18.3	830	10 30 R	410	1,142,670
No. 250	3.2	19,257	16,345	513	28.3	18.5	880	1 30 R	270	777,600
No. 251[7]	3.2	18,157	15,309	523	28.8	17.8	860	7 00 R	280	784,000
No. 252	3.2	17,996	15,244	497	29.5	18.3	830	8 00 L	395	1,276,390
No. 253	3.2	19,876	16,064	534	28.4	18.2	880	10 00 R	300	1,013,400
No. 254[8]	3.2	19,031	16,087	532	26.3	18	890	8 00 L	365	1,135,150
No. 255	3.2	19,875	16,579	605	24.9	16.5	1,000	0 30 L	345	1,111,590
No. 256	3.2	19,293	16,125	557	23.6	16.8	960	5 45 R	415	1,347,920
No. 257	3.2	20,112	16,784	564	22	16.6	1,010	1 30 L	275	990,000
No. 258	3.2	19,946	16,554	569	20.4	16	1,030	2 00 L	435	1,573,830
No. 259	3.2	21,636	17,792	648	19.3	15.2	1,170	1 00 R	330	1,262,360
No. 260	3.2	21,597	17,789	618	17.8	15.3	1,160	8 00 R	360	1,393,920
No. 261[9]	3.2	20,726	16,790	612	17.1	13.9	1,200	6 15 L	260	996,000

[1] Transit station, Spring.
[2] Transit station, Barney.
[3] Transit station, Levee.
[4] Transit station, Bank.
[5] Transit station, Camp.
[6] Transit station, Landing.
[7] Transit station, Pump.
[8] Transit station, Platform.
[9] Transit station, Rubb., Curle's Neck.

Available draught at high tide—Continued.

Section.	Rise and fall of tide.	Area in square feet.		Distance of center of area from right bank.	Depth of water at low tide.		Width.	Deflection of curve of center of area.	Distance to next section.	Tidal volume between sections.
		High tide.	Low tide.		Max.	Mean.		° ′		
No. 262	3.2	20,909	17,183	563	17.3	14.9	1,150	5 00 L	320	1,220,800
No. 263	3.2	21,646	17,742	588	16.9	14.9	1,190	4 30 R	375	1,500,000
No. 264[1]	3.2	21,884	17,788	609	17.6	14.2	1,250	2 00 L	430	1,780,200
No. 265	3.1	22,079	17,894	588	17.8	13.5	1,320	2 15 L	300	1,293,900
No. 266	3.1	22,208	17,868	611	17.8	13	1,370	14 30 L	200	906,000
No. 267	3.1	21,642	17,023	641	18.4	11.6	1,460	31 15 R	295	1,393,760
No. 268	3.1	23,494	18,658	622	18.4	12.2	1,530	25 00 L	445	2,193,405
No. 269	3.1	23,461	18,439	610	22.6	11.6	1,590	3 30 L	295	1,522,790
No. 270	3.1	24,939	19,638	593	21.7	11.6	1,680	5 00 R	245	1,344,305
No. 271[2]	3.1	24,323	18,650	579	23.6	10.3	1,800	5 00 L	280	1,523,480
No. 272	3.1	23,549	18,341	518	27.4	11.1	1,650	3 00 L	380	1,985,120
No. 273[3]	3.1	23,551	18,312	458	33.7	11	1,660	6 00 L	380	1,967,260
No. 274	3.1	24,110	18,995	362	41.7	11.7	1,620	10 15 L	375	1,889,250
No. 275	3.1	24,794	16,834	337	44.5	12.6	1,570	8 30 L	300	1,502,100
No. 276	3.1	25,071	20,018	383	40.6	12.5	1,600	2 30 R	300	1,502,100
No. 277	3.1	24,583	19,623	341	40.3	12.5	1,570	8 00 L	385	1,731,730
No. 278	3.1	24,837	20,801	386	41.2	13	1,530	6 00 L	455	1,919,645
No. 279	3.1	21,113	16,711	378	39.7	11.7	1,420	2 30 L	400	1,680,400
No. 280	3.1	22,974	18,975	373	44.6+	15	1,260	2 00 L	385	1,498,035
No. 281	3.1	20,368	16,586	347	41.9	13.9	1,190	9 00 L	375	1,329,750
No. 282[4]	3.1	22,776	19,366	352	45.2	18.1	1,070	1 15 L	300	976,500
No. 283[5]	3.1	22,295	19,195	346	42.4	19.8	970	5 30 R	320	962,240
No. 224	3.1	19,540	16,626	326	40.2	18.2	910	8 15 L	355	989,385
No. 285	3.1	22,004	19,345	378	35.6	22.3	860	3 15 R	305	799,100
No. 286	3.1	21,801	19,321	326	39.9	25.1	770	0 30 L	295	723,635
No. 287	3.1	20,987	18,662	300	40.6	25.9	720	6 00 L	315	737,415
No. 288	3.1	21,001	18,645	298	41.8	25.5	730	2 30 L	445	1,062,215
No. 289[6]	3.1	20,950	18,538	297	39.5	24.7	750	2 45 L	375	920,250
No. 290	3.1	20,332	17,842	218	37.1	23.2	770	0 30 L	325	812,825
No. 291	3.1	20,581	18,070	292	34.8	23.2	780	0 00	360	932,040
No. 292	3.1	20,798	18,132	325	32.5	21.8	830	0 30 L	420	1,119,720
No. 293	3.1	19,936	17,270	335	30.6	20.8	830	3 30 L	375	1,052,250
No. 294	3.1	20,445	17,500	385	27	19	920	0 30 R	365	1,097,555
No. 295	3.1	20,351	17,282	437	24.1	18	960	3 00 R	350	1,095,850
No. 296[7]	3.1	20,711	17,518	437	24.5	17.5	1,000	0 00	320	1,031,680

[1] Transit station, East.
[2] Transit station, Sulphur.
[3] Transit station, Bull.
[4] Transit station, Cap.
[5] Transit station, Mag.
[6] Transit station, Canyon.
[7] Transit station, Lee.

Available draught at high tide—Continued.

Section.	Rise and fall of tide.	Area in square feet.		Distance of center of area from right bank.	Depth of water at low tide.		Width.	Deflection of curve of center of area.	Distance to next section.	Tidal volume between sections.
		High tide.	Low tide.		Max.	Mean.		° ′		
No. 297	3.1	20,669	17,414	407	25.3	17	1,020	11 00 L	325	1,062,075
No. 298	3.1	20,855	17,569	438	25.1	17	1,030	1 00 R	350	1,166,560
No. 299	3.1	21,167	17,788	472	23.8	16.7	1,060	0 30 L	420	1,432,200
No. 300	3.1	21,774	18,333	461	26.5	17	1,080	2 15 L	395	1,304,290
No. 301	3.1	20,120	16,958	414	33.2	17.1	990	4 45 L	345	1,080,195
No. 302	3.1	20,954	17,854	375	32.1	18.4	970	2 30 R	285	879,225
No. 303	3.1	21,490	18,421	352	31.5	19.2	960	10 30 L	325	982,475
No. 304[1]	3.1	21,205	18,229	350	33.2	19.8	930	5 15 R	330	982,080
No. 305	3.1	21,779	18,803	345	33.8	20.2	930	5 15 L	350	1,036,350
No. 306	3.1	21,027	18,082	344	34.2	19.6	920	6 45 L	285	808,545
No. 307	3.1	20,177	17,449	321	36.3	20.5	850	1 30 R	375	917,375
No. 308	3.1	20,051	17,354	328	36.2	20.6	840	5 00 L	420	1,100,400
No. 309	3.1	19,492	16,950	292	39.4	21.4	790	4 45 L	385	934,830
No. 310[2]	3.1	20,367	17,794	310	40.7	22.2	800	0 45 L	295	718,030
No. 311	3.1	19,311	18,017	291	43.8	25.3	710	12 15 L	330	700,920
No. 312[3]	3.1	20,471	18,519	275	46.6	30.8	600	8 15 L	350	651,000
No. 313	3.1	20,678	18,911	292	48.9	35	540	0 00	305	534,360
No. 314	3.1	19,684	17,948	273	49.5	33.8	530	6 00 L	290	499,090
No. 315[4]	3.1	20,347	18,642	274	49.9	35.8	520	4 45 L	290	490,090
No. 316	3.1	20,164	18,428	271	47.3	34.7	530	3 15 R	295	525,985
No. 317[5]	3.1	20,106	18,277	268	43.2	32.6	560	7 15 L	355	555,930
No. 318[6]	3.1	19,743	18,441	269	43.7	31.2	590	12 00 L	335	555,765
No. 319	3.1	19,632	17,617	292	44.7	28.4	620	1 30 L	345	695,175
No. 320	3.1	20,235	18,220	256	44.9	29.3	620	14 30 L	330	1,000,230
No. 321	3.1	21,780	17,734	258	47.1	28.1	630	15 00 L	335	1,177,525
No. 322	3.1	19,024	17,040	284	44.5	27.9	610	0 15 L	355	876,495
No. 323[7]	3.1	19,864	17,911	270	42.6	29.8	600	2 00 L	340	680,000
No. 324	3.1	20,321	18,275	288	40	29	630	4 15 L	390	834,210
No. 325[8]	3.1	19,968	17,736	345	36.2	25.7	690	0 15 L	360	1,195,740
No. 326	3.1	25,110	18,155	385	31.4	23.2	780	8 00 L	385	1,882,815
No. 327	3.1	21,094	18,211	455	29.6	20.2	900	2 30 R	365	1,058,135
No. 328	3.1	20,404	17,490	504	27.7	19.2	910	4 45 R	335	1,023,090
No. 329	3.1	21,266	18,073	542	25.8	18	1,000	0 30 L	370	1,204,356
No. 330	3.1	21,626	18,309	588	26	17.6	1,040	3 00 R	140	468,720

[1] Transit station, Woodside.
[2] Transit station, Ann.
[3] Transit station, Barnet.
[4] Transit station, Presque Isle Wharf.
[5] Transit station, Peninsular.
[6] Transit station, Presque Isle.
[7] Transit station, Low.
[8] Transit station, Derby.

Available draught at high tide—Continued.

Section.	Rise and fall of tide.	Area in square feet.		Distance of center of area from right bank.	Depth of water at low tide.		Width.	Deflection of curve of center of area.	Distance to next section.	Tidal volume between sections.
		High tide.	Low tide.		Max.	Mean.		° ′		
No. 331[1]	3.1	21,921	18,602	596	25.3	17.5	1,060	0 30 L	360	1,235,760
No. 332	3.1	22,378	18,875	631	26.3	17.1	1,100	3 30 R	405	1,500,525
No. 333[2]	3.1	23,334	19,428	737	27.1	15.8	1,230	0 30 R	330	1,273,800
No. 334	3.1	22,708	18,895	702	30.1	15.7	1,200	3 00 R	345	1,529,385
No. 335	3.1	25,112	20,059	1,080	31.3	12.5	1,600	4 00 R	465	2,457,990
No. 336[3]	3.1	23,825	21,307	1,238	35.1	12.2	1,750	11 15 R	526	2,951,386
No. 337[4]	3.1	26,191	20,487	1,415	37	11.3	1,810	4 30 R	410	2,205,390
No. 338	3.1	25,389	20,336	1,221	32.9	12.7	1,600	8 00 R	530	2,809,530
No. 339	3.1	26,447	20,898	1,391	32.6	11.8	1,720	7 00 R	215	1,259,685
No. 340[5]	3.1	27,855	21,686	1,522	32.2	11	1,960	7 30 R	435	2,769,645
No. 341	3.1	26,309	19,744	1,613	27.9	9.3	2,120	7 15 R	420	2,798,040
No. 342	3.1	24,717	17,959	1,680	29.6	8.3	2,150	10 15 R	380	2,491,660
No. 343	3.1	26,292	19,937	1,615	34.7	9.8	2,020	2 15 R	285	1,824,570
No. 344[6]	3.1	27,223	20,775	1,669	40.8	10.1	2,050	17 15 R	420	2,649,780
No. 345	3.1	25,479	19,310	1,615	43.9	9.8	1,960	4 15 R	445	2,676,280
No. 346	3.1	26,800	20,941	1,480	47.1	11.2	1,860	16 00 R	465	2,659,800
No. 347	3.1	27,061	21,481	1,364	44.2	12.1	1,770	8 15 R	445	2,351,825
No. 348	3.1	25,032	20,042	1,173	35.4	12.7	1,580	5 00 R	470	2,258,350
No. 349	3.1	25,411	20,792	1,012	35.5	14.2	1,460	1 00 R	465	2,003,685
No. 350	3.1	24,299	20,300	832	33.9	16.1	1,260	1 45 R	505	1,855,370
No. 351	3.1	21,191	17,843	692	32.5	16.9	1,050	0 30 L	370	1,175,860
No. 352	3.1	21,497	18,490	594	33.3	19.4	960	5 00 R	395	1,261,235
No. 353[7]	3.1	20,679	17,300	698	34.1	16.3	1,060	7 30 L	390	1,354,080
No. 354	3.1	23,324	19,759	679	32.1	17.6	1,120	14 30 R	310	1,062,060
No. 355	3.1	22,621	19,335	655	31	18.7	1,030	6 15 R	310	994,790
No. 356	3.1	21,833	18,722	626	39	19.1	980	4 15 L	360	1,106,040
No. 357	3.1	22,294	19,287	566	37	20.5	940	10 30 R	309	1,010,739
No. 358	3.1	23,777	20,243	756	42	18.2	1,110	12 45 R	285	963,015
No. 359	3.1	22,715	19,491	652	43.2	19.3	1,010	8 00 R	300	972,000
No. 360	3.1	22,665	19,410	616	44.2	19	1,020	12 45 R	330	1,074,150
No. 361[8]	3.1	22,439	19,184	565	44	18.8	1,020	10 45 R	270	874,800
No. 362	3.1	23,276	20,052	519	45.2	19.8	1,010	13 00 L	380	1,176,100
No. 363	3.1	21,122	18,156	422	35.8	19.8	930	2 30 R	425	1,211,675
No. 364	3.1	20,905	18,169	392	34.9	22.1	820	5 00 R	400	1,106,000
No. 365	3.1	19,678	17,384	332	32.8	24.5	710	4 00 L	330	752,070

[1] Transit station, Sheep.
[2] Transit station, C. C. P.
[3] Transit station, Bremo.
[4] Transit station, Bend.
[5] Transit station, Willis.
[6] Transit station, Pickett.
[7] Transit station, Mercereau.
[8] Transit station, Wyatt.

Available draught at high tide—Continued.

Section.	Rise and fall of tide.	Area in square feet.		Distance of center of area from right bank.	Depth of water at low tide.		Width.	Deflection of curve of center of area.	Distance to next section.	Tidal volume between sections.
		High tide.	Low tide.		Max.	Mean.		° ′		
No. 366[1]	3.1	21,580	19,317	349	33.9	27.5	700	0 45 R	350	802,900
No. 367	3.1	24,161	21,836	385	35.3	30.3	780	2 30 R	310	711,140
No. 368	3.1	22,057	19,794	351	35.1	28.2	700	1 30 R	395	956,690
No. 369	3.0	24,967	22,387	458	35.4	26.9	830	8 30 R	385	1,004,850
No. 370[2]	3.0	24,267	21,627	480	34.6	25.4	850	7 00 R	345	947,025
No. 371	3.0	23,362	20,512	539	33.4	22.3	920	9 00 R	390	1,195,350
No. 372	3.0	24,802	21,622	633	35.3	20.9	1,030	9 00 R	390	1,243,850
No. 373	3.0	25,003	21,853	634	36	21.4	1,020	14 00 R	370	1,067,450
No. 374[3]	3.0	20,572	17,952	495	38.2	21.3	840	7 15 L	355	901,700
No. 375[4]	3.0	21,187	18,727	472	40.3	23.7	790	3 30 L	345	853,875
No. 376	3.0	21,936	19,446	473	37.8	24.3	800	3 15 R	335	869,325
No. 377	3.0	23,571	20,871	450	36.2	23.9	870	5 30 L	360	961,200
No. 378	3.0	23,798	21,158	490	35.6	24.9	850	8 00 R	390	1,029,600
No. 379	3.0	23,471	20,831	485	34.7	24.5	850	8 00 R	345	931,500
No. 380	3.0	25,714	22,954	470	33.2	25.8	890	6 45 L	410	1,169,050
No. 381	3.0	24,065	21,215	512	32	23	920	10 00 R	395	1,137,600
No. 382[5]	3.0	23,860	20,950	513	31.7	22.3	940	0 00	425	1,246,275
No. 383[6]	3.0	23,592	20,772	501	30.2	22.8	910	2 30 R	385	1,126,125
No. 384	3.0	22,808	19,778	511	28.3	20.2	980	0 00	385	1,181,100
No. 385	3.0	24,753	21,663	515	29.4	21.6	1,000	1 30 L	380	1,185,600
No. 386	3.0	24,671	21,521	538	26.8	21.1	1,020	3 15 R	410	1,295,650
No. 387	3.0	24,203	21,023	533	24.7	20.4	1,030	3 00 L	310	985,100
No. 388[7]	3.0	23,977	20,737	535	23.8	19.7	1,050	10 00 R	319	1,027,650
No. 389	3.0	24,300	20,910	552	23.5	19.0	1,100	13 00 L	335	1,130,625
No. 390	3.0	23,769	20,409	530	22.2	18.6	1,090	6 00 R	220	762,200
No. 391[8]	3.0	24,343	20,773	551	23.3	17.9	1,160	0 00	285	1,043,100
No. 392	3.0	25,005	21,255	551	23.5	17.4	1,220	2 30 R	295	1,123,055
No. 393	3.0	24,695	20,828	544	23.6	16.7	1,260	9 30 L	300	1,196,700
No. 394	3.0	25,565	21,455	578	22.7	16.0	1,340	4 15 R	240	1,011,600
No. 395	3.0	25,765	21,445	578	22.7	15.2	1,410	2 00 L	280	1,230,600
No. 396	3.0	26,083	21,613	584	22.8	14.7	1,460	2 15 R	320	1,448,600
No. 397	3.0	26,037	21.447	596	21.6	14.3	1,500	0 00	310	1,469,100
No. 398	3.0	26,998	22,168	620	21.4	14	1,580	3 45 L	380	1,881,000
No. 399[9]	3.0	26,859	21,789	656	23.1	13.1	1,660	13 30 R	275	1,435,500
No. 400	3.0	28,551	23,181	655	30.7	13.1	1,760	13 00 L	355	1,964,925

[1] Transit station, Harding's.
[2] Transit station, Stuck.
[3] Transit station, Brick.
[4] Transit station, Jack.
[5] Transit station, Royall.
[6] Transit station, Slush.
[7] Transit station, Duck.
[8] Transit station, Maple.
[9] Transit station, Marion.

Available draught at high tide—Continued.

Section.	Rise and fall of tide.	Area in square feet.		Distance of center of area from right bank.	Depth of water at low tide.		Width.	Deflection of curve of center of area.	Distance to next section.	Tidal volume between sections.
		High tide.	Low tide.		Max.	Mean.				
								° ′		
No. 401	3.0	29,837	24,137	670	31.1	12.8	1,870	2 00 R	350	2,042,250
No. 402	3.0	30,471	24,501	688	28	12.5	1,960	11 00 L	360	2,212,200
No. 403	3.0	30,943	24,523	736	22.4	11.1	2,110	13 30 R	320	2,097,600
No. 404	3.0	30,620	23,930	783	23.3	10.8	2,200	9 45 L	445	3,043,800
No. 405[1]	3.0	30,667	23,677	796	23	10.2	2,300	3 15 R	270	1,850,830
No. 406	3.0	30,758	24,038	619	24.2	10.8	2,210	10 00 L	365	2,458,275
No. 407	3.0	30,701	23,951	586	27.4	10.7	2,230	4 45 R	395	2,749,200
No. 408	3.0	31,029	23,859	542	28.2	10.1	2,360	0 00	365	2,602,450
No. 409[2]	2.0	31,957	24,868	573	25.9	10.2	2,430	6 00 L	410	3,076,530
No. 410	2.9	32,085	24,168	713	24.5	8.9	2,700	8 15 R	410	3,364,870
No. 411	2.9	34,330	25,833	648	23.7	8.9	2,900	6 00 L	600	5,464,200
No. 412	2.9	36,335	26,618	670	25.1	8	3,320	10 00 R	285	2,760,795
No. 413	2.9	35,622	25,965	637	25.2	7.8	3,300	12 15 L		

[1] Transit station, Bermuda. [2] Transit station, Alice.

COMMERCIAL STATISTICS.

[Richmond, Va., Custom-House Report.]

Vessels—steam and sail.

Year ending—	Cleared.	Entered.	Tonnage cleared.	Tonnage sailed.	Value of exports.	Value of imports.	Remarks.
June 30, 1889	429	465	319,355	328,746	$435,906	$28,570	The vessels varied in draught from 6 to 26 feet.
June 30, 1890	445	469	380,172	399,563	353,012	58,657	

Shipped from other points on the river, exclusive of Richmond and Newport News:

	Tons.
Coal	4,130
Iron	166
Cotton	125
Grain	3,923
Lumber	189,021
Cord-wood	157,896
Live cattle	1,766
Hay and shucks	1,658
Miscellaneous	30,523
Total	389,208

Received at other points on the river, exclusive of Richmond and Newport News:

Coal	200
Iron	300
Lumber	40
Miscellaneous	30,129
Total	30,669

Shipped from Newport News:

	Tons.
Coal	884,756
Cotton	9,483
Grain	61,144
Lumber	8,652
Live cattle	7,853
Hay and shucks	818
Bacon and beef	1,288
Lard	4,977
Flour	26,838
Tobacco	1,558
Miscellaneous	100,850
Total	1,114,217

Received at Newport News:

Iron	813
Coffee, grain	125
Live cattle	7
Salt	1,120
Miscellaneous	70,276
Total	72,341

Commercial statistics—Continued.

	Tons.
Shipped at Richmond:	
Coal	20,000
Cotton	1,090
Tobacco	14,920
Cigarettes and cigars	1,353
Flour	17,380
Total	54,743
Received at Richmond:	
Coal	60,000
Cotton	1,320
Grain	133,183
Ice	45,000
Flour	28,999
Total	268,502
Totals, including Richmond and Newport News:	
Shipped—	
Coal	908,886
Iron	166
Cotton	10,698
Tobacco	16,478
Grain	71,067
Lumber	190,673
Cord-wood	157,896
Cigarettes and cigars	1,353
Flour	44,218
Live cattle	9,619
Hay and shucks	2,476
Bacon and beef	1,288
Lard	4,977
Miscellaneous	131,373
Total	1,551,168
Received—	
Coal	60,200
Iron	1,113

	Tons.
Received—Continued.	
Cotton	1,320
Coffee, grain	125
Grain	133,183
Lumber	40
Live cattle	7
Ice	45,000
Flour	28,999
Salt	1,120
Miscellaneous	100,405
Total	371,512
Totals, including Richmond and excluding Newport News:	
Shipped—	
Coal	24,130
Iron	166
Cotton	1,215
Tobacco	14,920
Grain	3,923
Lumber	189,021
Cord-wood	157,896
Live cattle	1,766
Cigarettes and cigars	1,353
Flour	17,380
Hay and shucks	1,658
Miscellaneous	30,523
Total	443,951
Received—	
Coal	60,200
Iron	300
Cotton	1,320
Grain	133,183
Ice	45,000
Flour	28,999
Lumber	40
Miscellaneous	30,129
Total	299,171

NOTE.—By some it is claimed that the commerce of Newport News should be credited to the James River, and by others not. One of the tables shows the tonnage exclusive of that of Newport News, and another includes it.

I 3.

ESTABLISHMENT OF HARBOR-LINES IN THE JAMES RIVER, VIRGINIA, FROM RICHMOND TO CITY POINT.

RICHMOND, VA., *January* 4, 1890.

COLONEL: Owing to the improvements that have been made by the United States upon the James River during the last few years, the navigation of the river by vessels of greater draught has increased to such an extent that larger wharves are necessary to accommodate them.

The construction of such wharves is now contemplated by certain riparian owners. Under these circumstances, and owing to the physical nature of the river, the question of establishing port-warden lines in the river from Richmond to City Point becomes imperative. As it is understood that the Secretary of War is clothed with authority for causing such port-warden lines to be laid out, you are invited to bring this matter to his attention with the request that the same be done.

Yours, very truly and respectfully,

LEWIS D. CRENSHAW, Jr.,
Chairman City of Richmond Committee on Improvement of James River.

Col. W. P. CRAIGHILL,
Corps of Engineers, U. S. A.

[First indorsement.]

RICHMOND, VA., *January* 10, 1890.

Respectfully submitted to the Chief of Engineers.

In addition to the statement of Mr. Crenshaw, I am convinced from my own observation that the matter this letter refers to is one which should receive attention.

WM. P. CRAIGHILL,
Colonel of Engineers.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
January 17, 1890.

Respectfully submitted to the Secretary of War.

Section 12 of the river and harbor act of August 11, 1888, provides that—

Where it is made manifest to the Secretary of War that the establishment of harbor-lines is essential to the preservation and protection of harbors, he may, and is hereby authorized to cause such lines to be established beyond which no piers or wharves shall be extended or deposits made except under such regulations as may be prescribed from time to time.

It appearing from the within communication that the establishment of harbor-lines in the James River from Richmond to City Point is essential to the preservation and protection of that river, it is recommended that the proper steps be taken for their establishment. If this be approved, I further recommend that the subject be referred to a board of officers of the Corps of Engineers, to consist of Col. W. P. Craighill, Lieut. Col. P. C. Hains, and Lieut. G. J. Fiebeger, to be convened from this office, whose duty it shall be to make the necessary examinations and investigations to enable them to report fully upon the matter, and to indicate the lines proposed for adoption at as early a day as practicable.

It is also recommended that the expenses of the Board, including the cost of the required examination, be paid by Col. W. P. Craighill, Corps of Engineers, from the appropriation for "Improving James River, Virginia."

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Third indorsement.]

WAR DEPARTMENT,
January 18, 1890.

The recommendation of the Chief of Engineers is approved.

By order of the Secretary of War.

JOHN TWEEDALE,
Chief Clerk.

REPORT OF THE BOARD.

March 17, 1890.

GENERAL: The Board of Engineers, organized by Special Orders, No. 5, from the Headquarters of the Corps of Engineers, January 20, 1890,

to consider and report on the subject of the harbor-lines in James River from Richmond to City Point, Virginia, has the honor to submit the following report:

Public advertisement was made January 31, February 4, 7, 12, 14, and 15, in one of the principal newspapers of the city of Richmond of a proposed public meeting of the Board February 15, to which all persons interested were invited. In addition many special notices were sent to riparian owners and others in Richmond and elsewhere. The meeting was held in the rooms of the chamber of commerce, which were kindly placed at the disposal of the Board by the chamber.

The meeting was well attended and much interest was manifested in the subject before the Board. Among those present were the following, many of whom expressed their views:

John B. Purcell, president chamber of commerce.
Lewis D. Crenshaw, jr., chairman city committee on improvement of James River.
Mayor Attkisson, of Manchester.
H. D. Whitcomb, consulting engineer, Chesapeake and Ohio Railway.
F. Isaacs, engineer, Chesapeake and Ohio Railway.
George W. Allen, agent of the Old Dominion Steam-ship Company.
J. W. McCarrick, agent of the Clyde Line.
A. B. Clarke, president Old Dominion Iron and Nail Works.
J. Thompson Brown, and Apperson & Co., riparian owners,
Thomas Christian, of the James River improvement committee.
S. G. Tinsley, Richmond Chemical Works.
J. A. Allison and Homer Cox, riparian owners.

The Board examined the river from Mayo's Bridge in the city of Richmond to the Dutch Gap Cut-off, and the maps in the office of the engineer in charge of the improvement. A resurvey of a portion of the river below Drewry's Bluff is now in progress.

After full consideration the Board is of the opinion that harbor-lines should now be established from Mayo's Bridge to Drewry's Bluff, and recommends them as described in the appended papers and shown in detail upon the maps referred to.

The effort of the Board has been, in conforming to the provisions of the law, so to lay down the lines "beyond which no piers or wharves shall be extended or deposits made except under such regulations as may be prescribed from time to time" by the Secretary of War, that the channel prepared by the United States shall not be injured, the rights of riparian owners be duly maintained, and sufficient space be allowed for the outflow of the river at all times.

If there had been no wharves already built outside of the lines *e f*, *f g*, *g h*, and *h i*, the lines recommended in this report would have coincided still more nearly with the existing shore in that portion of the river, as the width is not great, and it is at a place where vessels are most likely to interfere with each other, whether passing or at the wharves.

While it is not proposed at this time to require the Chesapeake and Ohio Railway Company to cut off the part of their existing wharf which is outside the line *i j*, when the time comes for repairs, the front of the wharf should be limited to line *i j*.

The lines in front of wing-dams or training-walls are drawn 15 feet from them in order to clear the loaded mattresses placed in front of them to prevent undermining.

The temporary structure above the mooring ground of the monitors should be removed when they have left that position.

As the maps of the survey below Drewry's Bluff are yet unfinished, no attempt has been made to establish lines below that point.

A map in 7 sheets, on a scale of 1 inch to 100 feet, is sent in a separate roll by mail.

* * * * * * *

Respectfully submitted.

WM. P. CRAIGHILL,
Colonel, Corps of Engineers.
PETER C. HAINS,
Lieut. Col. of Engineers.
G. J. FIEBEGER,
First Lieut. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
March 27, 1890.

Respectfully submitted to the Secretary of War.

It being made manifest to the Secretary of War that the establishment of harbor-lines in the James River, from Richmond to City Point, was essential to the preservation and protection of that river, he approved the recommendation of this office that the subject be referred to a board of officers of the Corps of Engineers to make the necessary examinations and investigations to enable it to report fully upon the matter and to indicate the lines proposed for adoption.

The Board, constituted under this authority, having given the subject careful consideration, submits the within (first) report, with maps and description of the harbor-lines recommended for that portion of the river from Mayo's Bridge, in the city of Richmond, to Drewry's Bluff.

It is recommended that the lines proposed by the Board, described in the inclosed papers and delineated on the accompanying charts, be approved, and that the Secretary place his approval both upon the report and upon each of the tracings.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Second indorsement.]

WAR DEPARTMENT,
March 28, 1890.

Approved.

REDFIELD PROCTOR,
Secretary of War.

HARBOR-LINES FOR JAMES RIVER, VIRGINIA, FROM RICHMOND TO DREWRY'S BLUFF, RECOMMENDED BY A BOARD OF OFFICERS OF THE CORPS OF ENGINEERS, UNITED STATES ARMY, FEBRUARY, 1890.

STATIONS ON THE RIGHT OR CHESTERFIELD SIDE OF THE RIVER.

Station.	Distance.	True north.	Remarks.
	Feet.		
A	.....	.....	Edge of bridge on center line, third pier, Mayo's Bridge, reckoning from Manchester.
	1,580	S. 82° 20′ E.	
B	.....	.....	Point just outside of submerged pier.
	3,100	S. 58° 20′ E.	
C	.....	.....	Angle in masonry, upper end of Richmond and Danville Railroad Company's wharves at Rocketts.
	305	S. 49° 56′ E.	Along present face of masonry, Richmond and Danville wharf at Rocketts.
D	.....	.....	Angle in masonry.
	420	S. 38° 48′ E.	Along present face of masonry, Richmond and Danville wharf at Rocketts.
E	.....	.....	Point in river 25 feet from present corner of crib-work of wharf—Richmond and Danville wharf at Rocketts.
	745	S. 17° 38′ E.	
F	.....	.....	Screw dock—Point at upper outside edge.
	1,375	S. 1° 8′ E.	
G	.....	.....	Point is 15 feet outside of present end of Jetty No. B.
	400	S. 2° 32′ W.	
H	.....	.....	Point is 15 feet outside of present end of Jetty No. A.
	395	S. 2° 32′ W.	
I	.....	.....	Point is 15 feet outside of present end of Jetty No. 1.
	405	S. 3° 30′ W.	
J	.....	.....	Point is 15 feet outside of present end of Jetty No. 3.
	400	S. 4° 4′ W.	
K	.....	.....	Point is 15 feet outside of present end of Jetty No. 5.
	405	S. 4° 4′ W.	
L	.....	.....	Point is 15 feet outside of present end of Jetty No. 7.
	395	S. 5° 42′ W.	
M	.....	.....	Point is 15 feet outside of present end of Jetty No. 9.
	395	S. 10° 30′ W.	
N	.....	.....	Point is 15 feet outside of present end of Jetty No. 11.
	385	S. 14° 35′ W.	
O	.....	.....	Point is 15 feet outside of present end of Jetty No. 13.
	405	S. 16° 4′ W.	
P	.....	.....	Point is 15 feet outside of present end of Jetty No. 15.
	315	S. 18° 17′ W.	
Q	.....	.....	Point is 15 feet outside of present end of Jetty No. 17.
	360	S. 23° 57′ W.	
R	.....	.....	Point is 15 feet outside of present end of Jetty No. 19.
	415	S. 30° 13′ W.	
S	.....	.....	Point is 15 feet outside of present end of Jetty No. 21.
	405	S. 31° 37′ W.	
T	.....	.....	Point is 15 feet outside of present end of Jetty No. 23.
	405	S. 33° 52′ W.	
U	.....	.....	Point is 15 feet outside of present end of Jetty No. 25.
	395	S. 31° 47′ W.	
V	.....	.....	Point is 15 feet outside of present end of Jetty No. 27.
	360	S. 33° 17′ W.	
W	.....	.....	Point is 15 feet outside of present end of Jetty No. 29.
	335	S. 19° 49′ W.	
X	.....	.....	Point is 15 feet outside of present end of Jetty No. 31.
	385	S. 6° 57′ W.	
Y	.....	.....	Point is 15 feet outside of present end of Jetty No. 33.
	405	S. 2° 7′ W.	
Z	.....	.....	Quarry Wharf. Point is 15 feet outside face of present wharf at lower end.
	1,255	S. 11° 33′ E.	
A A	.....	.....	Point is 15 feet outside of present end of Jetty No. 35.
	2,030	S. 5° 8′ E.	
AB	.....	.....	Point is 15 feet outside of present end of Jetty No. 37.
	365	S. 2° 30′ E.	
AC	.....	.....	Point is 15 feet outside of present end of Jetty No. 39.
	535	S. 1° 8′ E.	
AD	.....	.....	Point is 15 feet outside of present end of Jetty No. 41.
	425	S. 0° 18′ E.	
AE	.....	.....	Point is 15 feet outside of present end of Jetty No. 43.
	345	S. 0° 29′ W.	
AF	.....	.....	Point is 15 feet outside of present end of Jetty No. 43½.
	395	S. 1° 37′ W.	
AG	.....	.....	Point is 15 feet outside of present end of Jetty No. 45.
	480	S. 1° 37′ W.	

HARBOR-LINES FOR JAMES RIVER, VIRGINIA—Continued.

STATIONS ON THE RIGHT OR CHESTERFIELD SIDE—Continued.

Station.	Distance.	True north.	Remarks.
	Feet.		
AH	.....	.....	Point is 15 feet outside of present end of Jetty No. 47.
	490	S. 4° 1′ W.	
AI	.....	.....	Point is 15 feet outside of present end of Jetty No. 49.
	455	S. 4° 1′ W.	
AJ	.....	.....	Point is 15 feet outside of present end of Jetty No. 51.
	495	S. 4° 9′ W.	
AK	.....	.....	Point is 15 feet outside of present end of Jetty No. 53.
	400	S. 1° 42′ W.	
AL	.....	.....	Point is 15 feet outside of present end of Jetty No. 55.
	410	S. 0° 25′ E.	
AM	.....	.....	Point is 15 feet outside of present end of Jetty No. 57.
	315	S. 0° 25′ E.	
AN	.....	.....	Point is 15 feet outside of present end of Jetty No. 59.
	295	S. 2° 29′ E.	
AO	.....	.....	Point is 15 feet outside of present end of Jetty No. 61.
	220	S. 4° 33′ E.	
AP	.....	.....	Point is 15 feet outside of present end of Jetty No. 61½.
	205	S. 5° 46′ E.	
AQ	.....	.....	Point is 15 feet outside of present end of Jetty No. 63.
	495	S. 5° 46′ E.	
AR	.....	.....	Point is 15 feet outside of present end of Jetty No. 65.
	510	S. 7° 46′ E.	
AS	.....	.....	Point is 15 feet outside of present end of Jetty No. 67.
	505	S. 12° 3′ E.	
AT	.....	.....	Point is 15 feet outside of present end of Jetty No. 69.
	445	S. 11° 8′ E.	
AU	.....	.....	Point is 15 feet outside of present end of Jetty No. 71.
	465	S. 12° 11′ E.	
AV	.....	.....	Point is 15 feet outside of present end of Jetty No. 73.
	2,425	S. 11° 16′ E.	
AW	.....	.....	Point is 15 feet outside of present end of Jetty No. 83.
	535	S. 6° 2′ E.	
AX	.....	.....	Point is 15 feet outside of present end of Jetty No. 85.
	510	S. 4° 47′ E.	
AY	.....	.....	Point is 15 feet outside of present end of Jetty No. 87.
	515	S. 0° 2′ W.	
AZ	.....	.....	Point is 15 feet outside of present end of Jetty No. 89.
	505	S. 1° 7′ W.	
AAA	.....	.....	Point is 15 feet outside of present end of Jetty No. 91.
	345	S. 6° 22′ W.	
AAB	.....	.....	Point is 15 feet outside of present end of Jetty No. 93.
	365	S. 6° 17′ W.	
AAC	.....	.....	Point is 15 feet outside of present end of Jetty No. 95.
	515	S. 10° 25′ W.	
AAD	.....	.....	Point is 15 feet outside of present end of Jetty No. 97.
	480	S. 13° 17′ W.	
AAE	.....	.....	Point is 15 feet outside of present end of Jetty No. 99.
	475	S. 18° 38′ W.	
AAF	.....	.....	Point is 15 feet outside of present end of Jetty No. 101.
	480	S. 25° 20′ W.	
AAG	.....	.....	Point is 15 feet outside of present end of Jetty No. 103.
	1,930	S. 28° 4′ W.	
AAH	.....	.....	Point is 15 feet outside of present end of Jetty No. 111.
	1,725	S. 26° 47′ W.	
AAI	.....	.....	Point is 15 feet outside of present end of Jetty No. 119.
	260	S. 23° 27′ W.	
AAJ	.....	.....	Point is 15 feet outside of present end of Jetty No. 121.
	250	S. 17° 32′ W.	
AAK	.....	.....	Point is 15 feet outside of present end of Jetty No. 123.
	245	S. 10° 55′ W.	
AAL	.....	.....	Point is 15 feet outside of present end of Jetty No. 125.
	245	S. 5° 24′ W.	
AAM	.....	.....	Point is 15 feet outside of present end of Jetty No. 127.
	245	S. 0° 19′ E.	
AAN	.....	.....	Point is 15 feet outside of present end of Jetty No. 129.
	245	S. 6° 16′ E.	
AAO	.....	.....	Point is 15 feet outside of present end of Jetty No. 131.
	250	S. 11° 47′ E.	
AAP	.....	.....	Point is 15 feet outside of present end of Jetty No. 133.
	990	S. 12° 23′ E.	
AAQ	.....	.....	Point is 15 feet outside of present end of Jetty No. 141.
	605	S. 14° 50′ E.	
AAR	.....	.....	Point is 15 feet outside of present end of Jetty No. 145.
	605	S. 28° 20′ E.	
AAS	.....	.....	Point is 15 feet outside of present end of Jetty No. 149.

HARBOR-LINES FOR JAMES RIVER, VIRGINIA—Continued.

STATIONS ON THE LEFT OR HENRICO SIDE OF THE RIVER.

Station.	Distance.	True north.	Remarks.
	Feet.		
a	.....	.....	Angle at the northwest corner of Shockoe Creek and James River, where masonry of retaining-wall of Richmond and Danville Railroad and Shockoe Creek meet.
	3,720	S. 53° 49′ E.	
b	.....	.....	This point is 190 feet, measured from the center line of the Ship Locks at right angles to its axis, taken at lower end of the masonry.
	1,355	S. 46° 3′ E.	
♥	.....	.....	Point is at angle in Clyde Line wharf, 150 feet from northwest corner of Gillies Creek and River.
	940	S. 23° 30′ E.	
d	.....	.....	Upper edge Davenport's Wharf.
	185	S. 14° 41′ E.	
e	.....	.....	Upper edge Dunlop & McCance's Wharf.
	895	S. 0° 43′ E.	
f	.....	.....	Cedar Works, upper edge of wharf.
	530	S. 0° 23′ W.	
g	.....	.....	Brewery, lower edge of wharf.
	1,760	S. 1° 20′ W.	
h	.....	.....	Point is 65 feet from outside edge of log training-wall, 55 feet up-stream side of piles of brickyard wharf.
	845	S. 6° 29′ W.	
i	.....	.....	Chesapeake and Ohio merchandise wharf. Point is 55 feet from outside edge of wharf, measured along its slant side. This would shorten the wharf 45 feet in direction at right angles to river.
	1,250	S. 10° 56′ W.	
j	.....	.....	Chesapeake and Ohio boat wharf. Point is on outside, upper edge.
	775	S. 21° 1′ W.	
k	.....	.....	Point is 15 feet outside present end of Jetty No. 16.
	1,285	S. 34° 19′ W.	
l	.....	.....	Point is 15 feet outside present end of Jetty No. 18.
	385	S. 31° 32′ W.	
m	.....	.....	Point is 15 feet outside present end of Jetty No. 20.
	385	S. 22° 11′ W.	
n	.....	.....	Point is 15 feet outside present end of Jetty No. 22.
	465	S. 12° 39′ W.	
o	.....	.....	Point is 15 feet outside present end of Jetty No. 24.
	475	S. 3° 58′ W.	
p	.....	.....	Point is 15 feet outside present end of Jetty No. 26.
	465	S. 10° 37′ E.	
q	.....	.....	Point is 15 feet outside present end of Jetty No. 28.
	645	S. 14° 25′ E.	
r	.....	.....	Point is 15 feet outside present end of Jetty No. 30.
	600	S. 7° 31′ E.	
s	.....	.....	Point is 15 feet outside present end of Jetty No. 32.
	555	S. 5° 49′ E.	
t	.....	.....	Point is 15 feet outside present end of Jetty No. 34.
	520	S. 4° 11′ E.	
u	.....	.....	Point is 15 feet outside present end of Jetty No. 36.
	400	S. 3° 55′ E.	
v	.....	.....	Point is 15 feet outside present end of Jetty No. 38.
	385	S. 2° 51′ E.	
w	.....	.....	Point is 15 feet outside present end of Jetty No. 40.
	275	S. 0° 1′ E.	
x	.....	.....	Point is 15 feet outside present end of Jetty No. 42.
	270	S. 0° 34′ W.	
y	.....	.....	Point is 15 feet outside present end of Jetty No. 44.
	220	S. 0° 28′ E.	
z	.....	.....	Point is 15 feet outside present end of Jetty No. 46.
	220	S. 0° 28′ E.	
aa	.....	.....	Point is 15 feet outside present end of Jetty No. 46½.
	590	S. 2° 7′ W.	
ab	.....	.....	Point is 15 feet outside of present end of training-wall at Richmond Bar.
	625	S. 3° 52′ W.	
ac	.....	.....	Point is 15 feet outside of present end of Jetty No. 48.
	460	S. 3° 52′ W.	
ad	.....	.....	Point is 15 feet outside of present end of Jetty No. 50.
	440	S. 3° 24′ W.	
ae	.....	.....	Point is 15 feet outside of present end of Jetty No. 52.
	465	S. 4° 35′ W.	
af	.....	.....	Point is 15 feet outside of present end of Jetty No. 54.
	365	S. 2° 51′ W.	
ag	.....	.....	Point is 15 feet outside of present end of Jetty No. 56.
	415	S. 0° 33′ W.	

HARBOR-LINES FOR JAMES RIVER, VIRGINIA—Continued.

STATIONS ON THE LEFT OR HENRICO SIDE OF THE RIVER—Continued.

Station.	Distance.	True north.	Remarks.
	Feet.		
ah	.....	.....	Point is 15 feet outside of present end of Jetty No. 58.
	315	S. 0° 16′ E.	
ai	.....	.....	Point is 15 feet outside of present end of Jetty No. 60.
	240	S. 2° 20′ E.	
aj	.....	.....	Point is 15 feet outside of present end of Jetty No. 62.
	495	S. 4° 3′ E.	
ak	.....	.....	Point is 15 feet outside of present end of Jetty No. 64.
	500	S. 8° 20′ E.	
al	.....	.....	Point is 15 feet outside of present end of Jetty No. 66.
	510	S. 10° 30′ E.	
am	.....	.....	Point is 15 feet outside of present end of Jetty No. 68.
	485	S. 11° 33′ E.	
an	.....	.....	Point is 15 feet outside of present end of Jetty No. 70.
	435	S. 11° 33′ E.	
ao	.....	.....	Point is 15 feet outside of present end of Jetty No. 72.
	475	S. 11° 39′ E.	
ap	.....	.....	Point is 15 feet outside of present end of Jetty No. 74.
	2,465	S. 11° 29′ E.	
aq	.....	.....	Point is 15 feet outside of present end of Jetty No. 84.
	535	S. 6° 38′ E.	
ar	.....	.....	Point is 15 feet outside of present end of Jetty No. 86.
	525	S. 5° 5′ E.	
as	.....	.....	Point is 15 feet outside of present end of Jetty No. 88.
	520	S. 2° 23′ E.	
at	.....	.....	Point is 15 feet outside of present end of Jetty No. 90.
	530	S. 1° 55′ W.	
au	.....	.....	Point is 15 feet outside of present end of Jetty No. 92.
	415	S. 3° 2′ W.	
av	.....	.....	Point is 15 feet outside of present end of Jetty No. 94.
	400	S. 8° 2′ W.	
aw	.....	.....	Point is 15 feet outside of present end of Jetty No. 96.
	525	S. 10° 25′ W.	
ax	.....	.....	Point is 15 feet outside of present end of Jetty No. 98.
	490	S. 14° 44′ W.	
ay	.....	.....	Point is 15 feet outside of present end of Jetty No. 100.
	515	S. 19° 34′ W.	
az	.....	.....	Point is 15 feet outside of present end of Jetty No. 102.
	495	S. 24° 34′ W.	
aaa	.....	.....	Point is 15 feet outside of present end of Jetty No. 104.
	3,710	S. 26° 45′ W.	
aab	.....	.....	Point is 15 feet outside of present end of Jetty No. 120.
	395	S. 20° 7′ W.	
aac	.....	.....	Point is 15 feet outside of present end of Jetty No. 124.
	395	S. 8° 2′ W.	
aad	.....	.....	Point is 15 feet outside of present end of Jetty No. 128.
	385	S. 3° 35′ E.	
aae	.....	.....	Point is 15 feet outside of present end of Jetty No. 132.
	215	S. 11° 03′ E.	
aaf	.....	.....	Point is 15 feet outside of present end of Jetty No. 134.
	995	S. 12° 5′ E.	
aag	.....	.....	Point is 15 feet outside of present end of Jetty No. 142.
	505	S. 14° 43′ E.	
aah	.....	.....	Point is 15 feet outside of present end of Jetty No. 146.
	500	S. 28° 10′ E.	
aai	.....	.....	Point is 15 feet outside of present end of Jetty No. 150.

STATIONS AROUND MAYO'S ISLAND.

I	.....	.....	Edge of Mayo's Bridge on south side, midway between first and second piers, reckoning from Mayo's Island on side next Manchester.
	1,350	S. 82° 20′ E.	
II	.....	.....	
	110	N. 7° 40′ E.	
III	.....	.....	
	370	N. 53° 49′ W.	
IV	.....	.....	
	515	N. 62° 07′ W.	
V	.....	.....	
	475	N. 82° 20′ W.	
VI	.....	.....	Edge of Mayo's Bridge on south side center line of first pier, reckoning from Mayo's Island on side next Richmond.

APPENDIX J.

IMPROVEMENT OF THE HARBOR AT NORFOLK AND ITS APPROACHES, VIRGINIA; APPROACH TO NORFOLK, VIRGINIA; NANSEMOND RIVER, VIRGINIA, AND APPOMATTOX RIVER, VIRGINIA; NORTH LANDING RIVER, VIRGINIA AND NORTH CAROLINA; CURRITUCK SOUND, COANJOK BAY AND NORTH RIVER BAR, NORTH CAROLINA.

REPORT OF LIEUTENANT G. J. FIEBEGER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1890, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Harbor at Norfolk and its approaches, Virginia.
2. Approach to Norfolk Harbor and the United States (Norfolk) navy-yard, between Lambert's Point and Fort Norfolk, Virginia.
3. Nansemond River, Virginia.
4. Appomattox River, Virginia.
5. North Landing River, Virginia and North Carolina.
6. Currituck Sound, Coanjok Bay, and North River Bar, North Carolina.
7. Removing sunken vessels or craft obstructing or endangering navigation.

HARBOR-LINES.

8. Establishment of harbor-lines of Norfolk and Portsmouth harbors and vicinity, Virginia.

UNITED-STATES ENGINEER OFFICE,
Norfolk, Va., July 2, 1890.

GENERAL: I have the honor to transmit herewith the annual reports for the year ending June 30, 1890, upon the works of river and harbor improvements in my charge.

Very respectfully, your obedient servant,

G. J. FIEBEGER,
First Lieut., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

J 1.

IMPROVEMENT OF HARBOR OF NORFOLK AND ITS APPROACHES, VIRGINIA.

No dredging has been done in the harbor or its approach since March, 1889. A survey of the harbor was made in August, 1889, to determine the condition of the channel.

APPENDIX J.

IMPROVEMENT OF THE HARBOR AT NORFOLK AND ITS APPROACHES, VIRGINIA; APPROACH TO NORFOLK, VIRGINIA; NANSEMOND RIVER, VIRGINIA, AND APPOMATTOX RIVER, VIRGINIA; NORTH LANDING RIVER, VIRGINIA AND NORTH CAROLINA; CURRITUCK SOUND, COANJOK BAY AND NORTH RIVER BAR, NORTH CAROLINA.

REPORT OF LIEUTENANT G. J. FIEBEGER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1890, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Harbor at Norfolk and its approaches, Virginia.
2. Approach to Norfolk Harbor and the United States (Norfolk) navy-yard, between Lambert's Point and Fort Norfolk, Virginia.
3. Nansemond River, Virginia.
4. Appomattox River, Virginia.
5. North Landing River, Virginia and North Carolina.
6. Currituck Sound, Coanjok Bay, and North River Bar, North Carolina.
7. Removing sunken vessels or craft obstructing or endangering navigation.

HARBOR-LINES.

8. Establishment of harbor-lines of Norfolk and Portsmouth harbors and vicinity, Virginia.

UNITED-STATES ENGINEER OFFICE,
Norfolk, Va., July 2, 1890.

GENERAL: I have the honor to transmit herewith the annual reports for the year ending June 30, 1890, upon the works of river and harbor improvements in my charge.

Very respectfully, your obedient servant,

G. J. FIEBEGER,
First Lieut., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

J 1.

IMPROVEMENT OF HARBOR OF NORFOLK AND ITS APPROACHES, VIRGINIA.

No dredging has been done in the harbor or its approach since March, 1889. A survey of the harbor was made in August, 1889, to determine the condition of the channel.

The channel in the Southern Branch has not shoaled appreciably since it was dredged in 1886–'87; there only remains a short shoal at its mouth.

The channel in the Eastern Branch dredged in 1884–'85 has shoaled about 1 foot.

This is probably due to three causes: (1) It was too narrow for easy navigation, and vessels have frequently grounded along its sides; (2) the main discharge pipe of the city sewerage system enters the river here; (3) the projection of the point near the Toll Bridge abutment throws the current against the docks opposite to it and causes an eddy and reduction of velocity along the docks near the mouth of the Eastern Branch, where the discharge pipe enters the river.

The first and last of these causes will be removed by the dredging proposed in the last annual report.

The channel elsewhere in the harbor and its approaches has sufficient depth and only needs greater width to accommodate the increasing commerce.

Since the last report two new railroads have been completed from Norfolk to the South and West; the Norfolk and Carolina and Atlantic and Danville railroads.

Money statement.

July 1, 1889, amount available	$2,430.09
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	426.19
July 1, 1890, balance available	2,003.90
Amount appropriated by act of September 19, 1890	150,000.00
Amount available for fiscal year ending June 30, 1891	152,003.00
Amount (estimated) required for completion of existing project	307,744.00
Amount that can be profitably expended in fiscal year ending June 30, 1892	150,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Approximate amount of freight of all kinds received or shipped by water.

[From records of Chamber of Commerce.]

	Tons.
1888	1,914,506
1889	2,243,087

Tabular statement of value of exports and imports and number and tonnage of vessels registered at the port of Norfolk, Va.

Years ending—	Foreign vessels.				Coastwise vessels.				Exports.	Imports.
	Entered.		Cleared.		Entered.		Cleared.			
June 30—	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*		
1883	64	29,572	135	112,529	1,314	1,248,461	818	1,099,266	$18,201,759	$167,157
1884	96	69,421	156	110,450	1,257	1,003,920	880	996,062	12,351,672	223,676
1885	66	70,711	127	102,821	1,330	1,078,484	1,450	1,275,477	14,797,046	128,372
1886	82	67,168	159	141,913	1,398	1,215,398	1,555	1,334,557	11,646,917	127,391
1887	73	73,896	208	207,428	1,432	1,261,365	1,719	1,432,016	14,393,337	99,958
1888	66	59,805	212	234,614	1,344	1,360,633	1,474	1,354,620	12,381,122	99,584
1889	51	64,975	227	256,351	1,328	1,286,573	1,402	1,290,013	13,865,586	176,253
Jan. 1, 1890	70	80,887	288	335,021	996	1,265,470	1,302	1,230,189	12,828,641	168,956

LETTER OF R. G. BANKS, COLLECTOR OF CUSTOMS.

CUSTOM-HOUSE, NORFOLK, VA.,
Collector's Office, May 23, 1890.

SIR: Inclosed, please find a statement of imports, exports, number of vessels entered and cleared, with their tonnage, both foreign and coastwise, at this port from January 1, 1889, to December 31, 1889.

Very respectfully,

R. G. BANKS, *Collector.*

Lieut. G. J. FIEBEGER, U. S. A.

IMPORTS.

Articles.	Quantity.	Value.	Articles.	Quantity.	Value.
Salt.....pounds..	21,594,459	$20,901	Whale-oil.....gallons..	3,835	$2,500
Guano.....tons..	1,946	98,825	Wine in bottles...dozen..	20	35
Kainit.....do...	3,996	27,486	Olives in casks.....	4	12
Phosphate.....do...	400	4,000	Miscellaneous.....	.....	105
Personal effects.....	.....	275			
Cotton-ties.....	896,000	12,458	Total.....	.....	166,958
Wine in casks.....	678	361			

EXPORTS.

Cotton.....bales..	243,982	$11,790,882	Rosin.....bbls.	1,820	$2,220
Coal.....tons..	88,190	245,122	Cattle.....head..	738	53,500
Staves.....	.....	286,553	Flour.....sacks..	.....	77,000
Lumber, etc.....	.....	200,801	Dry goods.....	.....	160
Tobacco.....	.....	186,925	Wheat.....bushels..	2,982	3,000
Corn.....	27,930	17,375	Miscellaneous.....	.....	443
Bark.....	.....	13,960			
Spirits turpentine..barrels.	1,000	20,000	Total.....	.....	12,828,641

NAVIGATION.

Direction.	Vessels cleared.		Vessels entered.	
	No.	*Tons.*	*No.*	*Tons.*
Foreign.....	288	335,021	70	80,887
Coastwise.....	1,302	1,230,189	996	1,265,470
Total.....	1,590	1,565,210	1,066	1,346,357

J 2.

IMPROVEMENT OF APPROACH TO NORFOLK HARBOR AND THE UNITED STATES NAVY-YARD AT NORFOLK, VIRGINIA.

The object of this improvement is to secure a channel 700 feet wide and 25 feet deep at ordinary low water by dredging and the construction of a dike.

The contract, made during the last fiscal year with P. Sanford Ross, was extended to July 10, 1889, by the Chief of Engineers, and completed.

Under this contract 816,000 cubic yards of material were removed by dredging. A survey made in August, 1889, revealed a channel of the desired width and depth, and no deterioration has been shown by recent examinations.

The construction of the dike therefore seems unnecessary, and no further appropriation is needed for this improvement.

For map see Reports of the Chief of Engineers, 1880, page 816; 1885, page 1026; 1887, page 970, and 1889, page 946.

For commercial statistics see report for "improvement of Harbor of Norfolk, and its approaches, Virginia."

Money statement.

July 1, 1889, amount available		$9,509.39
Amount received from officer for sale of fuel		10.50
		9,519.89
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$4,607.16	
July 1, 1890, outstanding liabilities	102.44	
		4,709.60
July 1, 1890, balance available		4,810.29
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		108,000.00

J 3.

IMPROVEMENT OF NANSEMOND RIVER, VIRGINIA.

The object of this improvement is, briefly, to secure a 12-foot low-water channel from Suffolk to Hampton Roads.

The contracts entered into with Charles Bliven and Chester T. Caler during the last fiscal year were both completed. The former finished the repairs on the Western Branch Dike August 2, 1889; his work consisted in replacing sheet-piling on 1,550 feet of the old dike and building 330 feet of new dike. The latter dredged a channel 40 feet wide and 11 feet deep at ordinary low water through Suffolk Shoal where the depth was formerly from 7 to 8 feet. The amount of material removed was 16,150 cubic yards and 28 saw-logs and piles.

Future work.—The dredging of a channel of the width and depth proposed will be carried on as rapidly as the money appropriated will admit. The ultimate cost will probably be increased beyond the estimate if the annual appropriations are less than $25,000.

For map of river see Annual Report of the Chief of Engineers for 1887, page 1002.

Money statement.

July 1, 1889, amount available	$3,891.37
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	2,465.88
July 1, 1890, balance available	1,425.49
Amount appropriated by act of September 19, 1890	10,000.00
Amount available for fiscal year ending June 30, 1891	11,425.49
Amount (estimated) required for completion of existing project	132,500.00
Amounted that can be profitably expended in fiscal year ending June 30, 1892	25,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

[Compiled by Mr. James Riddle, assistant engineer.]

Approximate amount of freight of all kinds received and shipped by water

	Tons.
1888	109,900
1889	217,738

J 4.

IMPROVEMENT OF APPOMATTOX RIVER, VIRGINIA.

The operations of the fiscal year consisted in making necessary repairs to works and plant and dredging shoals for the relief of commerce.

From the shoal at Puddledock Cut 8,910 cubic yards of material were removed in July and August, 1889; this shoal was reformed by the winter freshets.

From the shoal at Sunken Island 10,435 cubic yards were removed in April, May, and June, 1890. This dredging has resulted in a channel at least 40 feet wide, 11 feet deep, where formerly the depth was 8 to 9 feet.

The wing-dams constructed last year for the removal of Gatling's shoal have worked very successfully and formed a channel 11 feet deep and about 60 feet wide.

Future work.—It is proposed as rapidly as the money appropriated will admit to complete the wing-dams and training-walls for the South Channel.

The shoals of the river which were formerly distributed throughout its length will then be reduced to two, Magazine Bend and Puddledock Cut.

As stated in the last annual report, these shoals are due to causes which can only be removed at a great cost and it would seem best, therefore, to remove them by dredging as soon as they form. In order to do this, it is necessary to have a dredge and appliances always ready.

The city of Petersburg owns a dredge which is kept for the improvement of the harbor; this has been offered to the Government free of cost to be used in removing shoals below the harbor. It is proposed with this and the tow-boat and plant owned by the Government to dredge and maintain a channel through these shoals throughout the year. The cost of dredging is estimated at $1,000 a month. During the first year or two it will be necessary to keep the dredge at work nearly the entire year; after the regulating works are finished this will probably be decreased to eight or ten months of the year.

Money statement.

July 1, 1889, amount available		$5,132.77
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	$4,679.69	
July 1, 1890, outstanding liabilities	12.95	
		4,692.64
July 1, 1890, balance available		440.13
Amount appropriated by act of September 19, 1890		15,000.00
Amount available for fiscal year ending June 30, 1891		15,440.13
Amount (estimated) required for completion of existing project		15,080.00
Amount that can be profitably expended in fiscal year ending June 30, 1892		15,080.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Tabular statement of number and tonnage of vessels, and value of freight shipped and received at Petersburg, Va.

Years ending—	No.	Tonnage.	Value freights.	
			Shipped.	Received.
June 30—				
1881	645	35, 967	$74, 724	$412, 642
1882	917	43, 961	79, 154	519, 209
1883	980	46, 070	181, 763	569, 876
1884	924	46, 050	196. 458	612, 472
1885	893	40, 669	230, 508	529, 786
1886	953	68, 835	192, 053	474, 250
1887	836	63, 169	104, 923	304, 425
1888	599	30, 079	143, 673	372, 112
1889	595	27, 981	132, 072	270, 031
Jan. 1, 1890	598	29, 229	184, 596	323, 256

Approximate amount of freight of all kinds received and shipped by water.

	Tons.
1888	30, 626
1889	26, 121

LETTER OF W. E. MORRISON, PORT WARDEN.

PETERSBURG, VA., *May* 21, 1890.

DEAR SIR: Yours of 10th just at hand. Inclosed I hand you statement of commerce of the port of Petersburg from January 1, 1889, to January 1, 1890, as requested.

Very truly yours,

W. E. MORRISON,
Port Warden.

Commerce of the port of Petersburg from January 1, 1889, *to January* 1, 1890.

Articles.	Quantity.	Value.	Articles.	Quantity.	Value.
Inward.			Melons	1, 300	$152
Anthracite coal ... tons	5, 684	$34, 104	Furniture	.....	2, 200
Bituminous coal ... do	1, 286	6, 414	Machinery	.....	500
Guano ... do	457	18, 400	Merchandise	.....	30, 425
Fertilizers ... do	7, 387	76, 428	Total	.....	323, 256
Scrap-iron ... do	40	400	*Outward.*		
Ice ... do	1, 352	12, 578			
Hay ... do	38	695			
Slate, scrap ... do	150	150	Lumber ... feet	693, 358	8, 600
Wheat ... bushels	11, 579	11, 434	Wood ... cords	2, 686	11, 542
Corn ... do	3, 539	1, 695	Railroad ties	550	220
Oats ... do	2, 347	1, 301	Merchandise	.....	164, 233
Peanuts ... do	53, 675	80, 186			
Oysters ... do	3, 115	1, 664	Total	.....	154, 596
Shells ... do	12, 500	380			
Potatoes ... do	5, 295	4, 410	*Summary.*		
Lime ... do	4, 940	500			
Cotton ... bales	717	35, 530	Inward commerce	.....	323, 256
Sumac ... bags	1, 507	764	Outward commerce	.....	184, 596
Tobacco ... hogsheads	54	2, 917			
Hogs	16	28	Grand total	.....	507, 852

J 5.

IMPROVEMENT OF NORTH LANDING RIVER, VIRGINIA AND NORTH CAROLINA.

The object of this improvement is to secure a channel 9 feet deep and 80 feet wide from North Landing Bridge to Ferraby's Island, Currituck Sound.

The project was completed June 30, 1884, since which time the operations have consisted in removing logs abandoned by rafts.

Between December 1, 1889, and January 4, 1890, with a hoister hired in open market, 732 logs and numerous stumps were removed and the river cleared of obstructions throughout its length.

After the obstructions were removed the channel was in a very good condition. It is probable that some dredging will be necessary from time to time to remove shoals caused by vessels grounding outside of the channel.

Future work.—The only operations contemplated for the present are the removal of obstructions. The balance on hand will suffice and no further appropriation is necessary.

This river forms part of the inland water route from Norfolk to Albemarle Sound.

For map see Annual Report of the Chief of Engineers for 1889, page 962.

Money statement.

July 1, 1889, amount available	$3,629.69
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	964.38
July 1, 1890, balance available	1,665.31

J 6.

IMPROVEMENT OF CURRITUCK SOUND, COANJOK BAY, AND NORTH RIVER BAR, NORTH CAROLINA.

The object of this improvement is to secure a 9-foot channel at ordinary low stages of water through these waters.

The river and harbor act of August 11, 1888, appropriated $7,500 for this improvement. A project for its expenditure was submitted to the Chief of Engineers and duly approved.

In accordance therewith proposals were invited August 28, 1889, for dredging near Long Point, Currituck Sound, and on September 9, 1889, a contract was entered into with P. Sanford Ross, the lowest bidder, to do the work for 28½ cents per cubic yard.

He commenced work October 31, 1889, and finished January 6, 1890, having removed 21,494 cubic yards of material and 71 logs. This work resulted in a channel 60 to 80 feet wide, 9 feet deep, and 4,250 feet long where the depth was formerly from 5 to 8 feet. The shoal thus dredged was formed by the washing of the sides; the material taken out was removed over a mile from the channel.

Future work.—The channel through Currituck Sound is somewhat obstructed by sunken logs, but otherwise in a good condition. The

channel through Coanjok Bay is obstructed by sunken logs and has shoaled through the washing of the sides. It is estimated that the obstructions can be removed and the channel through Coanjok Bay restored by an expenditure of $20,000. It is not proposed to widen the channel through North River Bar until the light-house establishment place the range beacons proposed for the channel already dredged.

Money statement.

July 1, 1889, amount available	$7,495.04
July 1, 1890, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1889	6,651.20
July 1, 1890, balance available	843.84
Amount (estimated) required for completion of existing project	39,885.68
Amount that can be profitably expended in fiscal year ending June 30, 1892. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	20,000.00

Abstract of proposals for dredging in Currituck Sound, North Carolina, received and opened at noon of August 28, 1889, by Lieut. G. J. Fiebeger, Corps of Engineers.

No.	Name and address of bidder.	Commence.	Complete.	Price per cubic yard.
				Cents.
1	Chester T. Caler, Norfolk, Va	April 1, 1890	August 10, 1890	35
2	P. Sanford Ross, Jersey City, N. J	In ninety days	Two months from date of commencing.	28½
3	American Dredging Company, Philadelphia, Pa.			29½

Contract awarded P. Sanford Ross.

COMMERCIAL STATISTICS.

Number, class, and tonnage of vessels passing through Albemarle and Chesapeake Canal, Currituck Sound, etc.

Years ending—	Steamers.	Schooners.	Barges.	Lighters.	Sloops.	Rafts.	Tonnage.
June 30—							
1885	2,976	1,059	613	133	204	181	.....
1886	3,271	1,082	549	55	178	244	336,737
1887	3,369	1,216	568	49	181	207	358,111
1888	3,864	1,362	361	44	265	378	435,745
1889	4,065	1,539	683	82	353	352	445,237
June 1, 1890	4,169	1,699	878	67	446	335	454,956

Approximate amount of all kinds of freight passing through this route.

[From records of Albemarle and Chesapeake Canal Company.]

	Tons.
1888	335,758
1889	372,617

LETTER OF MR. FRANKLIN WELD, PRESIDENT ALBEMARLE AND CHESAPEAKE CANAL COMPANY.

OFFICE OF THE ALBEMARLE AND CHESAPEAKE CANAL COMPANY,
Norfolk, Va., May 24, 1890.

SIR: I beg leave to acknowledge receipt of your communication of May 20, and herewith inclose a statement of the trade through this canal for the time, as requested.

Hoping this may furnish you the information you desire, if not we will be pleased to give any further details you may wish and be in time for your report,

I am, yours, very respectfully,

FRANKLIN WELD,
President.

Lieut. G. J. FIEBEGER, U. S. A.

Statement of merchandise, etc., passed through Albemarle and Chesapeake Canal for year ending January 1, 1890.

GOING NORTH.

Articles.	Quantity.	Articles.	Quantity.
Cotton.....bales..	34,901	Potatoes.....bushels..	77,977
Fish.....barrels..	9,860	Corn.....do....	105,844
Naval stores.....do....	21,050	Peanuts.....bags..	6,828
Spirits turpentine.....do...	580	Rice.....bushels..	10,486
Rags.....pounds..	21,680	Wheat.....do....	352
Old iron.....do.....	129,209	Water melons.....number..	205,484
Eggs.....crates..	2,001	Lumber.....B. M. feet..	134,521,006
Bacon.....pounds..	3,250	Shingles.....	38,687,685
Wood.....cords..	980	Staves.....	773,033
Peas and beans.....bushels..	6,318	Laths.....	6,365,100
Railroad-ties.....number..	97,587	Passengers.....	3,155

GOING SOUTH.

Articles.	Quantity.	Articles.	Quantity.
Bread.....barrels..	2	Crates of ware.....	333
Beef and pork.....do..	15,429	Lime and cement.....casks..	3,676
Cider and beer.....do...	1,140	Oyster-shells.....bushels..	20,450
Flour.....do....	54,328	Iron.....pounds..	3,003,494
Fish.....do....	737	Guano.....tons..	5,389
Molasses.....do....	2,647	Hay.....bales..	33,631
Spirits.....do....	2,649	Salt.....sacks..	10,457
Sugar.....do..	3,293	Agricultural lime.....bushels..	505,514
Coffee.....sacks..	1,572	Oil.....barrels..	4,184
Hats and shoes.....cases..	4,294	Coal.....tons..	3,575
Soap and candles.....boxes..	3,297	Ice.....do...	4,156
Tobacco.....do...	4,703	Passengers.....	1,970
Nails.....kegs..	3,281		

J 7.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

On April 6, 1889, the wreck of the bark *E. L. Pettingill* was reported to this office as obstructing navigation. After a personal examination, authority was granted to take the necessary steps for its removal. After being duly advertised, proposals for its removal were invited, and on August 10, 1889, a contract was entered into with Mr. George McBlair to remove it for $1,325.

Between August 14 and 30, 1889, it was entirely destroyed by the use of explosives, no wreckage being saved.

J 8.

ESTABLISHMENT OF HARBOR LINES OF NORFOLK AND PORTSMOUTH HARBORS AND THEIR ADJACENT WATERS.

a. HARBOR LINES FOR SOUTHERN BRANCH OF ELIZABETH RIVER AND FOR ELIZABETH RIVER BELOW FORT NORFOLK.

UNITED STATES ENGINEER OFFICE,
Baltimore, Md., January 20, 1890.

GENERAL: I have the honor to submit herewith a report of this date of the Board of Engineers on the establishment of harbor-lines for Norfolk and Portsmouth, Va., constituted by Special Orders 13, series of 1889, from your headquarters. The map is sent in a separate roll by mail.

Very respectfully, your obedient servant,
WM. P. CRAIGHILL,
Colonel of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
January 21, 1890.

Respectfully submitted to the Secretary of War.

It appearing that the establishment of harbor-lines of Norfolk and Portsmouth and their vicinity is essential to the preservation and protection of the harbors, the Secretary of War, by indorsement of February 2, 1889 (papers herewith), approved the recommendation of the Chief of Engineers that a Board of Officers of the Corps of Engineers, be constituted to establish harbor-lines of Norfolk and Portsmouth and their vicinity, in accordance with the provisions of section 12 of the river and harbor act of August 11, 1888.

The Board having submitted the within (2d) report and accompanying tracing, on which the proposed lines for the Southern Branch of Elizabeth River and for Elizabeth River below Fort Norfolk are drawn, it is recommended that the lines selected be approved, and that the approval of the Secretary be placed on the tracing submitted.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

NOTE.—The approval of the Secretary of War, dated January 23, 1890, is placed upon map accompanying this report.

REPORT OF BOARD OF ENGINEERS.

JANUARY 20, 1890.

* * * * * * *

The Board met * * * November 7 and December 20. At both meetings were present the president and members of the State harbor commissioners and chief engineer and division engineer of the Norfolk and Western Railroad.

An opportunity was given all to express their views on the interests affected by the establishment of the new harbor-lines.

The Board finds that no lines have hitherto been established along the navy-yard in the Southern Branch; in the Elizabeth River below Fort Norfolk lines were adopted in December, 1883, by the State harbor commissioners on the recommendation of an Advisory Board, constituted as described in our first report.

The line between Fort Norfolk and Lambert's Point was afterwards changed by the State harbor commissioners in October, 1886.

A full description of the lines and the reasons therefor is given in the annual reports of the harbor commission for 1884 and 1886–'87. These reports were laid before the Board for its information, but no printed copies could be obtained for transmission herewith.

After carefully examining existing lines and structures, the Board recommends the adoption of the following lines, in continuation of those previously recommended and adopted:

SOUTHERN BRANCH OF ELIZABETH RIVER.

Portsmouth side.—From (K) the line follows the front of the existing sea-wall and wharves of the U. S. Navy-Yard to (l) the upper corner of the wharf at the entrance of the timber dry-dock; thence in a straight line 655 feet to (*m*), which is in the prolongation of the southern boundary-wall of the navy-yard and 245 feet from its extremity.

Berkley side.—From XX, the lower corner of St. Helena Wharf, the line runs straight and parallel to the masonry sea-wall of the navy-yard 1,800 feet to XIX; thence in a straight line 1,370 feet to XVIII, the lower corner of Johnson's Wharf; thence along the face of said wharf about 619 feet to XVII, its upper end.

The establishment of these lines, in connection with those already adopted, will make the ruling width of the Southern Branch 620 feet; thus admitting of a channel 500 feet wide and 25 feet deep, as contemplated in the latest project for the improvement of this harbor.

ELIZABETH RIVER BELOW FORT NORFOLK.

Norfolk side.—From (A) the lower corner of the wharf at Fort Norfolk the line runs N. 44° 30′ W. 2,900 feet to (B′); thence N. 47° 56′ W. 5,700 feet to (C′); thence N. 40° 08′ W. 700 feet to (D′); thence N. 25° 25′ W. 1,000 feet to (E′) the upper corner of the elevated coal pier at Lambert's Point; thence along the face of said pier in rear of the light-house to (F′) its upper corner.

Portsmouth side.—From the point (a) previously established the line runs N. 49° W. 2,900 feet to (1); thence N. 89° 45′ W. 1,480 feet to (2); thence S. 80° 55′ W. 5,022 feet to (3) a point opposite and 1,200 feet from the upper pier at Love's Point.

In the establishment of these lines, the Board was governed by the following considerations:

1. To preserve a wide entrance into the inner harbor, between Pinner's Point and Fort Norfolk.

2. To preserve a large area at the mouth of the Western Branch for the anchorage of large and small vessels using this port.

3. To interfere as little as possible with the plans of existing and contemplated structures based on lines previously laid down, provided such structures did not unduly contract the channel and interfere with navigation.

Two creeks empty into the Elizabeth River between Fort Norfolk and Lambert's Point, Tarrant's and Lambert's; we recommend that an opening of 400 feet be left in the harbor-line for the former and an opening of 600 feet for the latter, these openings to be located as shown on the accompanying map.

The lines thus far recommended meet the present needs of these har-

bors. They will be further extended when the contemplated construction of new docks creates a necessity for them.

In examining this harbor the Board finds that along many of the harbor-lines there have been constructed solid lines of wharves without slips. Vessels loading or unloading at such wharves necessarily contract the water-way reserved for general navigation. It is the sense of this Board that no such constructions be allowed in the future, but that all wharves be constructed with suitable slips in which vessels may lie, thus preserving the entire channel limited by the harbor-lines for the movement of vessels in the harbor.

Respectfully submitted.

WM. P. CRAIGHILL,
Colonel Corps of Engineers.
PETER C. HAINS,
Lieut. Col. of Engineers.
G. J. FIEBEGER,
First Lieut. Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

---

b. HARBOR-LINES FOR EASTERN, SOUTHERN, AND WESTERN BRANCHES OF ELIZABETH RIVER, FOR ELIZABETH RIVER BELOW WESTERN BRANCH, AND BULKHEAD LINES IN NORFOLK HARBOR FROM NORFOLK AND WESTERN RAILROAD BRIDGE AND UNITED STATES NAVY-YARD TO LAMBERT'S POINT.

NORFOLK, VA., *April* 30, 1890.

* * * * * * *

The Board met * * * at 10 a. m., April 8, 1890; present, Col. William P. Craighill, Corps of Engineers, First Lieut. G. J. Fiebeger, Corps of Engineers; absent, Lieut. Col. Peter C. Hains, Corps of Engineers.

The following citizens of Norfolk and vicinity were present and were given an opportunity to express their views on the matters under consideration: Charles G. Elliott, president State Harbor Commission; V. D. Groner, W. G. Elliott, W. H. Doyle, T. W. M. Draper, M. P. Rue, and W. S. Johnson. Letters were also received from W. W. Cole, Chief Engineer Norfolk and Western Railroad, and Col. William Lamb.

The applications for the extension of the harbor-lines in the eastern, southern, and western branches and the Elizabeth River were laid before the Board and carefully considered.

It having been made manifest to the Board that the establishment of harbor-lines in the eastern, southern, and western branches and the Elizabeth River, where not already done, is necessary for the preservation of the harbor, the Board recommends pier and bulkhead lines for the waters as given below.

As stated in a previous report, the Board finds the construction of wharves in this harbor, in many cases, very faulty, no slips having been provided for the reception of vessels loading and unloading.

To prevent the continuance of this class of structures, the Board recommends the adoption of bulkhead lines in addition to pier lines, and further recommends that no deposits and no structures except piers with suitable slips along the sides be allowed to extend beyond the bulkhead lines.

Eastern Branch, from Norfolk and Western Railroad Bridge to Broad Creek.

PIER LINES.

	Feet.
North Bank:	
T to U, N. 81° 28′ E	2,790
U to V, N. 81° 28′ E	290
V to W, S. 77° 44′ E	4,250
W to X, S. 71° 30′ E	1,670
X to Y, S. 88° 45′ E	1,500
Y to Z, N. 76° 10′ E	3,640
Z to AA, N. 17° 45′ E	670
BB to CC, S. 17° 45′ W	870
CC to DD, S. 63° 45′ E	1,370
South Bank:	
XXVIII to XXIX, N. 82° 07′ E	2,855
XXIX to XXX, S. 81° 00′ E	1,450
XXX to XXXI, S. 78° 16′ E	2,650
XXXI to XXXII, S. 71° 20′ E	700
XXXII to XXXIII, S. 74° 40′ E	2,000
XXXIII to XXXIV, N. 75° 51′ E	3,780
XXXIV to XXXV, S. 88° 48′ E	900
XXXV to XXXVI, S. 67° 45′ E	1,450

Point BB is at eastern end of draw of Norfolk and Virginia Beach Railroad Bridge. The distance from AA to BB is 560 feet.

BULKHEAD LINES.

These lines are parallel to and 250 feet from the pier lines given above.

Southern Branch, from United States Navy Yard to Money Point.

PIER LINES.

	Feet.
East Bank.	
XVII to XVI, S. 0° 00′ E	550
XVI to XV, S. 19° 47′ E	1,950
XV to XIV, S. 2° 00′ E	1,080
XIV to XIII, S. 17° 13′ W	1,740
XIII to XII, S. 6° 10′ E	1,150
XII to XI, S. 20° 05′ W	1,030
XI to X, S. 26° 55′ W	1,600
X to IX, S. 48° 09′ W	1,220
IX to VIII, S. 68° 22′ W	1,350
VIII to VII, S. 41° 00′ W	350
VII to VI, S. 20° 00′ W	450
VI to V, S. 1° 00′ W	850
West Bank.	
m to *n*, S. 17° 00′ W	390
n to *o*, S. 4° 30′ E	800
o to *p*, S. 20° 00′ E	930
p to *q*, S. 11° 30′ E	960
q to *q′*, along face of Nottingham & Wrenn's wharf.	
q′ to *r*, S. 17° 55′ W	1,420
r to *s*, S. 0° 15′ E	2,500
s to *t*, S. 27° 04′ W	1,500
t to *u*, S. 55° 50′ W	560
u to *v*, S. 68° 45′ W	1,730
v to *w*, S. 52° 45′ W	890
w to *x*, S. 28° 50′ W	570
x to *y*, S. 0° 00′ W	1,230

BULKHEAD LINES.

These lines are parallel to and 250 feet from the pier lines given above.

Western branch, from toll-bridge to its mouth.

PIER LINES.

	Feet.
South bank:	
1 to 2, N. 89° 45′ W	1,480
2 to 3, S. 80° 55′ W	5,020
3 to 4, S. 82° 26′ W	2,050
4 to 5, S. 51° 56′ W	2,060
5 to 6, S. 28° 30′ W	4,700
North Bank:	
36 to 37, N. 24° 52′ E	5,300
37 to 38, N. 65° 54′ E	2,400
38 to 39, N. 84° 26′ E	1,800
39 to 40, N. 80° 46′ E	1,275
40 to 41, N. 45° 30′ E	2,150

Point (6) is east face of bridge, 120 feet from south end of draw.
The distance from 6 to 36 is 650 feet.

BULKHEAD LINES.

These lines are parallel to and 250 feet from the pier-lines given above.

Elizabeth River below Western Branch.

PIER LINES.

	Feet.
East bank:	
F′ to G′, N. 24° 55′ E	10,370
West bank:	
41 to 42, N. 37° 40′ W	3,975
42 to 43, N. 8° 35′ W	2,200
43 to 44, N. 52° 45′ W	3,700

BULKHEAD LINES.

From pier line:	
From F′ to G′	400
From 41 to 43	400
From 43 to 44	250

Bulkhead lines in harbor from Norfolk and Western Railroad Bridge and United States Navy-Yard to Lambert's Point.

	Feet.	
From XVIII to XXIV	250	Inside of pier line already established.
XXIV to XXVI	300	Do.
XXVI to XXVIII	250	Do.
d to *a*	400	Do.
a to 1	400	Do.
C to B	300	Do.
A to E′	400	Do.

Wherever in the harbor or its adjacent waters the ordinary low-water shore-line is nearer to the pier line than 250 feet, this shore-line shall become the bulkhead line.

WM. P. CRAIGHILL,
Colonel, Corps of Engineers.
PETER C. HAINS,
Lieut. Col. of Engineers.
G. J. FIEBEGER,
First Lieut., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
May 8, 1890.

Respectfully submitted to the Secretary of War.

It appearing that the establishment of the harbor-lines of Norfolk and Portsmouth and their vicinity is essential to the preservation and protection of the harbors, the Secretary of War, by indorsement of February 2, 1889 (paper herewith), approved the recommendation of the Chief of Engineers that a Board of Officers of the Corps of Engineers be constituted to establish the harbor lines of Norfolk and Portsmouth and their vicinity, in accordance with the provisions of section 12 of the river and harbor act of August 11, 1888.

The Board having submitted the within report and accompanying tracings, on which the proposed pier and bulkhead lines for Eastern Branch of Elizabeth River from Norfolk and Western Railroad Bridge to Broad Creek; for Southern Branch of Elizabeth River from United States Navy-Yard to Money Point; for Western Branch of Elizabeth River from Toll Bridge to its mouth, and for Elizabeth River below Western Branch, and bulkhead lines in the harbor from Norfolk and Westen Railroad Bridge and United States Navy Yard to Lambert's Point, are drawn, it is recommended that the lines selected be approved, and that the approval of the Secretary be placed on the report and on the tracings submitted.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Second indorsement.]

WAR DEPARTMENT,
May 9, 1880.

Approved.

REDFIELD PROCTOR,
Secretary of War.

INDEX.

Subject.	Page. Part I.		Part II.	Part III.	Part IV.
A.					
Act, proposed, to facilitate collection of commercial statistics	14				
Adamson, W. M. B. (canal-boat), removal of wreck of	121		1085		
Agate Bay Harbor, Minn., improvement of	241			2283	
Ahnapee Harbor, Wis., improvement of	251			2338	
Alabama Great Northwestern Railway Company, bridge of, across Alabama River	336				
Alabama River, Ala., improvement of	166		1654		
Alabama River, near Montgomery, Ala., bridge over	366				
Allegheny River, Pa., improvement of	227			2194	
Allegheny River, Pa., dam at Herr's Island, construction of	227			2198	
Alloway Creek, N. J., examination and survey of	92	906			
Altamaha River, Ga., improvement of	144		1369		
Alterations of bridges obstructing navigation	13	338			
Amicus (barge), removal of wreck of	121		1084		
Amite River, La., improvement of	177		1740		
Andersonville and Augusta, Ga., Savannah River between, examination and survey of	147		1484		
Anna A. Holton (schooner), removal of wreck of	37	516			
Apalachicola Bay, Fla., improvement of	157		1623		
Apalachicola River, Fla., improvement of	156		1621		
Appomattox River, Va., improvement of	106	1025			
Appoquinimink Creek, Del., examination and survey of	102	943			
Approach to Norfolk Harbor and navy-yard, between Lambert's Point and Fort Norfolk, Va., improvement of	105	1023			
Approaches to Norfolk Harbor, Va., improvement of	104	1021			
Aqueduct Bridge, D. C., to Mount Vernon, Va., survey of road from	350				3563
Aqueduct, Washington	345				3501
Aquia Creek, Va., examination and survey of	121		1096		
Aransas Pass and Bay up to Rockport and Corpus Christi, Tex., improvement of	185		1810		
Arkansas River, Ark., improvement of	197			1932	
Arkansas River, Ark. and Kans., removing obstructions	196			1928	
Arkansas River, near Cumming's Landing, Ark., bridge over	337				
Arkansas River, near Fort Smith, Ark., bridge over	338				
Arthur Kill, N. Y. and N. J., improvement of	76	843			
Ashland Harbor, Wis., improvement of	244			2295	
Ashby River, S. C., improvement of	136		1205		
Ashtabula Harbor, Ohio, improvement of	296			2783	
Ashtabula Harbor, Ohio, wreck in, removal of	296			2787	
Atchafalaya and Red rivers, rectification of					3308
Augusta, Ga., protection of, from floods			1484		
Augusta, Ga., Savannah River above, examination and survey of	147		1484		
Augusta, Ga., Savannah River above, improvement of	143		1365		
Augusta and Andersonville, Ga., Savannah River between, examination and survey of	147		1484		
Augusta and Savannah, Ga., Savannah River between, improvement of			1324		
Au Sable Harbor, Mich., improvement of	279			2723	
B.					
Back Cove Channel, Portland Harbor, Me., bridge obstructing	343				
Back Cove Channel, Portland Harbor, Me., improvement of	21	445			
Bagaduce River, Me., improvement of	17	432			
Baltimore Harbor, Md., and channel to Baltimore, improvement of	102	987			
Barren, Green and, rivers, Ky., operating and care of locks and dams on	237			2255	
Bartholomew Bayou, La. and Ark., improvement of	189			1882	
Battalion of Engineers	11	393			
Battlefields, maps of	354				
Bayou Bartholomew, La. and Ark., improvement of	189			1882	

Subject.	Page. Part I.		Part II.	Part III.		Part IV.	
Bayou Bœuf, La., improvement of	190			1885			
Bayou Buffalo, Tex., improvement of	185		1807				
Bayou, Cedar, Tex., bar at mouth of, examination and survey of	186		1815				
Bayou Courtableau, La., improvement of	179		1747				
Bayou, Cypress, and the lakes between Jefferson, Tex., and Shreveport, La., improvement of	195			1826	1914		
Bayou D'Arbonne, La., improvement of	189			1879			
Bayou Dorcheat, La., improvement of				1827			
Bayou La Fourche, La., improvement of	177		1472				
Bayou La Grange, Fla., improvement of	158		1625				
Bayou Macon and Tensas River, La., improvement of	190			1888			
Bayou Plaquemine, La., improvement of	178		1746				
Bayou Plaquemine, La., securing mouth from further caving	182		1761				
Bayou, Steeles, Miss., improvement of	193			1900			
Bayou Terrebonne, La., improvement of	178		1745				
Bay Ridge (steamer), removal of wreck of	62	667					
Beaufort and Coosaw River, S. C., Beaufort River between, examination and survey of	141		1234				
Beaufort and Newbern, N. C., inland water way between, improvement of	125		1127				
Beaufort Harbor, N. C., improvement of	126		1131				
Beaufort Harbor and New River, N. C., inland water way between, improvement of	127		1138				
Beaufort River, S. C., from Beaufort to Coosaw River, and at Brickyard, examination and survey of	141		1234				
Belfast Harbor, Me., examination and survey of	26	455					
Belfast Harbor, Me., improvement of	18	435					
Bellamy River, N. H., improvement of	25	452					
Bellefontaine Bluffs, Mo., bridge over Missouri River at	337						
Benedict and Hill's Landing, Md., Patuxent River, between, improvement of	111		1060				
Benjamin Gartside (schooner), removal of wreck of	50	585					
Beverly, Ohio, bridge over Muskingum River at	341						
Beverly Harbor, Mass., examination and survey of	38	524					
Big Black River, Miss., improvement of	191			1890			
Big Hatchee River, Tenn., improvement of	193			1904			
Big Sandy River, W. Va. and Ky., improvement of	239			2274			
Big Sandy River, bridge over Ohio River about 1½ miles above mouth of	337						
Big Sunflower River, Miss., improvement of	193			1901			
Bill, proposed, to facilitate collection of commercial statistics	14						
Bills authorizing construction of bridges, examinations and reports on	13						3449
Bills authorizing construction of bridges over Mississippi River at New Orleans, La	13					3449	3453
Biloxi Harbor, Miss., improvement of	172		1709				
Black Lake Harbor, Mich., improvement of	271			2652			
Black River, Ark. and Mo., improvement of	200			1948			
Black River, Ark. and Mo., obstruction of, by rafts, and injury to dam							3498
Black and Ouachita rivers, Ark. and La., improvement of	188			1871			
Black River, Mich., mouth of, improvement of	283			2735			
Black River, Mo., improvement of	201			1950			
Black River, N. C., improvement of	128		1145				
Black River Harbor, Ohio, improvement of	294			2775			
Black Rock Harbor, Conn., improvement of	57	640					
Black Warrior River, Ala., from Tuscaloosa to Daniels Creek, improvement of	168		1696				
Block Island, R. I., harbor of refuge at, improvement of	47	575					
Board of Engineers, The	6						
Bœuf, Bayou, La., improvement of	190			1885			
Bogue Falia and Tchefuncte River, La., improvement of	175		1737				
Bogue Sound, N. C., improvement of			1138				
Boston and Lowell Railroad Company, bridge of, over Charles River, Mass	340						
Boston and Maine Railroad Company, bridge of, over Charles River, Mass	340						
Boston, Mass., bridges of city of, over Charles River	340						3470
Boston, Mass., bridges over Charles River at	340						3470
Boston, Mass., defenses of	4						
Boston Harbor, Mass., establishment of harbor lines in	331	532					
Boston Harbor, Mass., improvement of	33	497					
Brazos Santiago Harbor, Tex., improvement of	185		1812				
Breakwater, near life-saving station, East Point Judith, R. I., construction of, examination and survey for	51	592					
Breakwater at Gordon's Landing, Lake Champlain, Vt., construction of	307			2877			
Breakwater from Mount Desert to Porcupine Island, Me., construction of	16	430					

Subject.	Page. Part I.	Part II.	Part III.	Part IV.
Breakwater at mouth of Narrow River, Narragansett Bay, R. I., construction of, examination and survey for	51 595			
Breakwater at New Haven Harbor, Conn., construction of	54 622			
Breakwater at Petoskey Harbor, Mich., examination and survey for	274		2668	
Breakwater at Rouse's Point, Lake Champlain, N. Y., construction of	306		2875	
Breakwater at mouth of Saco River, Me., improvement of	22 446			
Breakwaters, etc., occupation or injury of, by corporations or individuals	13 344			3489
Breton Bay, Leonardtown, Md., improvement of	112	1062		
Brickyard, Beaufort River at, S. C., examination and survey of	141	1234		
Bridge over Eastern Branch of the Potomac River, D. C., construction of	110	1048		
Bridge over Mill Creek at Fort Monroe, Va	9 387			
Bridgeport Harbor, Conn., improvement of	56 636			
Bridges and roads in Yellowstone National Park, construction and improvement of	352			3591
Bridges obstructing navigation	13 338			
Bridges over navigable waters, examinations of plans and locations of proposed	13 335			
Bridging navigable waters of the United States	13 335			3449
Broad Creek, Del., improvement of	98 933			
Broad Creek, near Laurel, Del., bridge over	335			
Broadkiln River, Del., improvement of	96 928			
Brook Neal and Pig River, Staunton River, Va., between, improvement of	120	1082		
Brook Neal and Randolph, Staunton River, Va., between, improvement of	119	1081		
Brown's Creek, Sayville, N. Y., examination and survey of	63 669			
Brunswick Harbor, Ga., improvement of	146	1404		
Brush Creek, Ohio, bridge over Muskingum River near mouth of	336			
Buckhannon River, W. Va., improvement of	240		2279	
Buffalo Bayou, Tex., improvement of	185	1807		
Buffalo Harbor, N. Y., improvement of	299		2208	
Bull's Bay and Charleston Harbor, S. C., waters connecting, examination and survey of	141	1239		
Burlington Harbor, Vt., improvement of	308		2879	
Buttermilk Channel, New York Harbor, N. Y., improvement of	69 724			
C.				
Cable-galleries	5			
Cache River, Ark., improvement of	200		1946	
Cahaba River, Ala., improvement of	165	1651		
Calcasieu River and Pass, La., improvement of	180	1750		
Caloosahatchie River, Fla., improvement of	151	1596		
Calumet Harbor, Ill., improvement of	260		2404	
Calumet Harbor, Ill., use of piers in				3497
Calumet River, Ill. and Ind., improvement of	262		2576	
Cambridge, Mass., bridges of city of, over Charles River	340			3470
Cambridge, Mass., bridges over Charles River at	340			3470
Cambridge Harbor, Md., improvement of	101 940			
Cambridge Harbor, Md., wreck in, removal of	101 942			
Camden, Ark., Ouachita River above, improvement of	188			
Camden, N. J., and Philadelphia, Pa., harbor between, improvement of	86 882		1878	
Camden Harbor, Me., improvement of	19 436			
Canal, Cascades, Columbia River, Oregon, construction of	326			3052
Canal, Coosa River, Ga. and Ala., operating and care of locks and dams on	167	1658		
Canal, Des Moines Rapids, operating and care of	209		2064	
Canal, Fox River, Wis., operating and care of locks and dams on	258		2378	
Canal, Great Kanawha River, W. Va., operating and care of locks and dams on	233		2246	
Canal, Green and Barren rivers, Ky., operating and care of locks and dams on	237		2255	
Canal, Illinois and Mississippi, location of	263		2580	
Canal, Kentucky River, Ky., operating and care of locks and dams on	238		2266	
Canal, La Grange Lock, Illinois River, operating and care of	262		2574	
Canal, Louisville and Portland, operating and care of	230		2221	
Canal, Monongahela River, W. Va. and Pa., operating and care of locks and dams on	226		2192	
Canal, Monongahela River, purchase of lock and dam No. 7	226		2193	
Canal, Muskingum River, Ohio, operating and care of locks and dams on	228		2201	
Canal, St. Clair Flats, Mich., improvement of	283		2737	

Subject.	Page. Part I.		Part II.	Part III.	Part IV.
Canal, St. Clair Flats, Mich., operating and care of	285			2739	
Canal, St. Mary's Falls, Mich., operating and care of	276			2695	
Canarsie Bay, N. Y., improvement of	75	839			
Caney Fork River, Tenn., improvement of	223			2149	
Caney Fork River, between Smith and Putnam counties, Tenn., bridge over	337				
Cape Ann, Mass., Sandy Bay, harbor of refuge at, improvement of	29	488			
Cape Charles City Harbor, and approaches by Cheuton Inlet, Va., examination and survey of	102	971			
Cape Fear, North East River, N. C., examination and survey of	133		1181		
Cape Fear River, N. C., above Wilmington, improvement of	129		1148		
Cape Fear River, N. C., at and below Wilmington, improvement of	130		1152		
Cape Henry, Va., wreck in Chesapeake Bay, in channel between Hampton Roads and, removal of	108	1029			
Carquinez, Straits of, Cal., etc., survey of	311				2890
Carthage and Edinburgh, Pearl River, Miss., between, improvement of	173		1711		
Carthage and Jackson, Pearl River, Miss., between, improvement of	173		1713		
Cascades Canal, Columbia River, Oregon, construction of	326				3052
Casemates, torpedo	5				
Casilda (barge), removal of wreck of	92	905			
Cedar Bayou, Galveston Bay, Tex., bar at mouth of, examination and survey of	186		1815		
Cedar Keys Harbor, Fla., improvement of	155		1609		
Cedar River Harbor, Mich., improvement of	248			2327	
Celilo Falls, Columbia River, Oregon and Wash., overcoming obstructions at					3028
Central Vermont Railroad Company, bridge of, over Missisquoy Bay, Vt	343				
Ceredo, W. Va., bridge over Ohio River about one mile below	337				
Champlain, Lake, bridge between North and South Hero islands, Vt	336				
Champlain, Lake, channel between North and South Hero islands, Vt., improvement of	307			2876	
Champlain, Lake, Narrows at, N. Y. and Vt., improvement of	309			2883	
Channel in Back Cove, Portland Harbor, Me., improvement of	21	445			
Channel to Baltimore, Md., improvement of	102	987			
Channel, Buttermilk, New York Harbor, N. Y., improvement of	69	724			
Channel in Galveston Bay, Tex., improvement of	183		1797		
Channel, Grosse Pointe, Mich., improvement of	285			2740	
Channel, Hay Lake, Mich., improvement of	277			2714	
Channel between Lake Ontario and Irondequit Bay, N. Y., report on				2853	
Channel, Lubec, Me., improvement of	15	428			
Channel at Mount Vernon, Va., Potomac River, improvement of	112		1061		
Channel between North and South Hero islands, Lake Champlain, N. Y., improvement of	307			2876	
Channel between Staten Island and New Jersey, improvement of	77	846			
Charles River, Boston and Cambridge, Mass., bridges obstructing	310				3470
Charleston Bar, S. C., wreck at, removal of	141		1233		
Charleston Harbor, S. C., improvement of	134		1190		
Charleston Harbor and Bull's Bay, S. C., waters connecting, examination and survey of	141		1239		
Charlevoix Harbor and entrance to Pine Lake, Mich., improvement of	264			2610	
Charlotte Harbor, N. Y., improvement of	302			2849	
Charts of Northern and Northwestern Lakes, printing and distribution of	351				3588
Chattahoochee River, Ga. and Ala., improvement of	164		1645		
Chattanooga, Tenn., Tennessee River above, improvement of	216			2112	
Chattanooga, Tenn., Tennessee River below, improvement of	217			2114	
Cheyboygan Harbor, Mich., improvement of	278			2719	
Chehalis River, Wash., improvement of	323				2984
Chesapeake Bay, wreck in channel between Cape Henry and Hampton Roads, Va., removal of	108	1029			
Chesapeake Bay, wreck between Hooper's and Kedge's straits, removal of	942				
Chesapeake Bay, wreck near Sharp's Island, removal of	101	942			
Chester River, between Crumpton and Jones' Landing, Md., examination and survey of	102	954			
Cheuton Inlet, Va., approaches to Cape Charles City Harbor by, examination and survey of	102	971			

Subject.	Page. Part I.	Part II.	Part III.	Part IV.
Chicago and West Michigan Railway Company, bridge of, over St. Joseph River, Mich	340			
Chicago Harbor, Ill., improvement of	259		2399	
Chicago Harbor, Ill., use of piers in				3496
Chickahominy Creek (River), Va., examination and survey of	121	1085		
Chickahominy River, Va., improvement of	119	1079		
Chief of Engineers, office of the	356			
Chincoteague Bay, Va., and Delaware Bay near Lewes, Del., water way between, improvement of	97 930			
Chincoteague Inlet, Va., examination and survey of	102 980			
Chippewa River, including Yellow Banks, Wis., improvement of	212		2084	
Chippewa River, Wis., surveys for reservoirs at sources of	215		2098	
Choctawhatchee River, Fla. and Ala., improvement of	160	1631		
Choptank River, Md., improvement of	100 938			
Choptank River, Md., wreck in, removal of	101 942			
City Point and Richmond, Va., James River between, establishment of harbor lines in	333 1012			
Clark Creek, S. C., improvement of	136	1203		
Clarksville and Eaton Falls, Roanoke River, Va., between, examination of	133	1175		
Cleveland Harbor, Ohio, improvement of	294		2777	
Clinch River, Tenn., improvement of	220		2131	
Clinton Harbor, Conn., improvement of	54 616			
Clinton River, Mich., improvement of	286		2742	
Clubfoot River, N. C., improvement of		1127		
Coanjok Bay, North River Bar, and Currituck Sound, N. C., improvement of	108 1027			
Coaster's Harbor Island, R. I., cove and water way near, examination and survey of	51 590			
Cocheco River, N. H., improvement of	25 453			
Cocheco River, N. H., from Dover to its mouth, examination and survey of	26 475			
Cockle's Creek, Va., wreck at mouth of, in Great Wicomico River, removal of	121	1085		
Columbia, Department of the, report of engineer officer on operations in	355			3599
Columbia Falls, Pleasant River from, to its mouth, Me., examination and survey of	26 467			
Columbia River, Oregon, canal at the Cascades, construction of	326			3052
Columbia River, Oregon and Wash., overcoming obstructions at Dalles and Celilo Falls, and at Three and Ten Mile Rapids				3028
Columbia River, Oregon, gauging waters of	329			3064
Columbia and Lower Willamette rivers below Portland, Oregon, improvement of	327			3058
Columbia River, Oregon and Wash., mouth of, improvement of	325			3011
Columbia, Upper, and Snake rivers, Oregon and Wash., improvement of	322			2981
Columbia River, Wash., between Wallula and British line, examination and survey of	329			3065
Columbus County, N. C., bridges over Lumber River	343			
Commercial statistics, proposed legislation to facilitate collection of	14			
Conecuh and Escambia rivers, Fla. and Ala., improvement of	161	1634		
Congaree River, S. C., improvement of	139	1224		
Connecticut River above Hartford, Conn., improvement of	52 606			
Connecticut River below Hartford, Conn., improvement of	52 608			
Contentnia Creek, N. C., improvement of	123	1115		
Coos Bay, entrance to, Oregon, improvement of	318			2929
Coosa River, Ga. and Ala., improvement of	162	1640		
Coosa River, Ga. and Ala., operating and care of locks and dams	167	1658		
Coosa River, Ala., from rapids at Wetumpka to improvements above Ten Islands, examination and survey of	167	1658		
Coosaw River and Beaufort, Beaufort River between, S. C., examination and survey of	141	1234		
Coquille River, Oregon, improvement of	317			2924
Cornwall, N. Y., bridge across Moodna or Murderers Creek	342			
Coronado, Cal., establishment of harbor lines in front of	334			2904
Corporations or individuals, occupation or injury of piers, breakwaters, etc., by	13 344			3489
Corps of Engineers, laws affecting, 51st Congress, 1st session				3607
Corps of Engineers, officers of the	3			
Corps of Engineers, statement of rank and duties of officers of the	358			
Corpus Christi, Tex., Aransas Pass and Bay up to, improvement of	185	1810		
Corsica Creek, Md., improvement of	100 937			
Cotton Gin, Miss., and Vienna, Ala., Tombigbee River between, examination and survey of	175	1716		
Courtableau Bayou, La., improvement of	179	1747		
Cove near Coaster's Harbor Island, R. I., examination and survey of	51 590			

Subject.	Page. Part I.		Part II.	Part III.	Part IV.
Covington and Macon Railroad Company, bridge of, over Ocmulgee River, Ga	343				
Cowlitz River, Wash., improvement of	329				3063
Coxsackie and Troy, N. Y., Hudson River between, establishment of harbor lines in	332	766			
Crane and Waters rivers of Essex Branch, Mass., examination and survey of	38	517			
Crumpton and Jones's Landing, Chester River between, Md., examination and survey of	102	954			
Cumberland River, improvement of				2133	
Cumberland River, above Nashville, Tenn., improvement of	222			2136	
Cumberland River, below Nashville, Tenn., improvement of	221			2134	
Cumberland River, from Nashville, Tenn., to its mouth, examination and survey of	223			2151	
Cumberland River, South Fork of, Ky., improvement of	222			2148	
Cumberland Sound, Ga. and Fla., improvement of	146		1422		
Cummings Landing, Ark., bridge over Arkansas River near	337				
Currituck Sound, Coanjok Bay and North River Bar, N. C., improvement of	108	1027			
Cuttyhunk Island, Mass., wreck at, removal of	50	584			
Cuttyhunk Pond, Mass., wreck at, removal of	50	584			
Cypress Bayou and the lakes between Jefferson, Tex., and Shreveport, La., improvement of	195			1826, 1914	
D.					
Dalles, Columbia River, Oregon and Wash., overcoming obstructions at					3028
Dam, Davis Island, Ohio River, operating and care of	226			2186	
Dam, Herrs Island, Allegheny River, Pa., construction of	227			2198	
Dan River, Va. and N. C., improvement of	120		1083		
Daniels Creek and Tuscaloosa, Black Warrior River, Ala., between, improvement of	168		1696		
Daniels Ferry, La., bridge over Tensas River near	337				
D'Arbonne Bayou, La., improvement of	189			1879	
Davids Island, New York Harbor, sea wall and earth embankment at	5	382			
Davis Island Dam, Ohio River, operating and care of	226			2186	
Decatur County, Tenn., bridge over Tennessee River at	336				
Defenses, seacoast	4				
Delaware Bay, Del., ice harbor at head of, construction of	89	887			
Delaware Bay, near Lewes, Del., and Chincoteague Bay, Va., water way between, improvement of	97	930			
Delaware Bay, near Lewes, Del., pier in, construction of	89	888			
Delaware Bay, wrecks in, removal of	92	905			
Delaware Bay and River, removal of wrecks from	92	904			
Delaware Breakwater Harbor, Del., improvement of	90	889			
Delaware River, Pa. and N. J., improvement of	84	866			
Demopolis and Tuscaloosa, Warrior River, Ala., between, examination and survey of	175		1716		
Department of the Columbia, report of engineer officer on operations in	355				3599
Department of the Platte, report of engineer officer on operations in	355				3601
Departments, military, reconnaissances and explorations in	354				3599
Des Moines Rapids, Mississippi River, improvement of	208			2060	
Des Moines Rapids and Illinois River, Mississippi River between, improvement of	206			2005	
Des Moines Rapids and Minneapolis, Mississippi River between, improvements of	208			2033	
Des Moines Rapids Canal, dry dock at	209			2070	
Des Moines Rapids Canal, operating and care of	209			2064	
Detroit, Mich., bridge over Detroit River at	13				3456
Detroit, Mich., tunneling Detroit River at	13				3462
Detroit River, Mich., improvement of	287			2745	
Detroit River, at Detroit, Mich., bridge over	13				3456
Detroit River, at Detroit, Mich., tunneling	13				3462
Detroit River, at Grosse Pointe, Mich., examination and survey of	289			2749	
Distribution of charts of Northern and Northwestern Lakes	351				3588
District of Columbia, public buildings and grounds, improvement and maintenance of	349				3535
District of Columbia, water supply	346				3522
Division engineers	14				
Division of the Missouri, report of engineer officer on operations in	355				3600
Division of the Pacific, report of engineer officer on operations in	355				3603
Divisions, engineer	14				
Divisions, military, reconnaisances and explorations in	354				3599
Dorcheat, Bayou, La., improvement of				1827	

Subject.	Page. Part I.		Part II.	Part III.	Part IV.
Dover, N. H., Cocheco River from, to its mouth, examination and survey of	26	475			
Dredge-boats and snag-boats on Upper Mississippi River, operation of	207			2021	
Dry-dock at Des Moines Rapids Canal	209			2070	
Dry-dock at St. Mary's Falls Canal, Mich	276			2714	
Duck Creek, Del., improvement of	94	923			
Duluth, Minn., examination and survey of	247			2310	
Duluth Harbor, Minn., improvement of	242			2285	
Dunkirk Harbor, N. Y., improvement of	288			2804	
Duties of officers of the Corps of Engineers, statement of	358				
E.					
Eagle Harbor, Mich., improvement of	245			2299	
East Chester Creek, N. Y., improvement of	60	656			
East Point Judith, R. I., coast near life-saving station, examination and survey of	51	592			
East River, N. Y., removal of ledge from Broome street to Twenty-third street, New York City, examination and survey for	74	761			
East River and Hell Gate, N. Y., removal of obstructions in	66	713			
East River and Hell Gate, Y. Y., use of dike in					3491
East Tennessee, Virginia and Georgia Railway Company, bridges of, over Ocmulgee River, Ga	343				
East Tennessee, Virginia and Georgia Railway Company, bridge of, over Tennessee River	339				
Eastern Branch of the Potomac River, D. C., bridge across, construction of	110		1048		
Eastern Railroad Company, bridge of, over Charles River, Mass	340				
Eaton Falls and Clarksville, Roanoke River, Va., between, examination of	133		1175		
Echo Harbor, New Rochelle, N. Y., improvement of	60	652			
Edgartown, Mass., inner and outer harbor at, Martha's Vineyard, examination and survey of	50	585			
Edinburgh and Carthage, Pearl River, Miss., between, improvement of	173		1711		
Edisto River, S. C., improvement of	136		1206		
Elizabeth River, N. J., improvement of	79	852			
Elk River, Md., examination and survey of	102	965			
Elk River, W. Va., improvement of	234			2247	
Ellen R. (schooner), removal of wreck of	50	584			
E. L. Pettingill (bark), removal of wreck of	108	1029			
Embankments and sea-walls	5				
Engineer Depot, Post of Willets Point, N. Y	11	398			
Engineer divisions	14				
Engineer School of Application, Post of Willets Point, N. Y	10	392			
Engineers, Battalion of	11	393			
Engineers, Chief of, Office of the	356				
Engineers, Corps of, laws affecting, 51st Congress, 1st session					3607
Engineers, Corps of, officers of the	3				
Engineers, Corps of, statement of rank and duties of officers of the	358				
Engineers, division	14				
Engineers, The Board of	6				
Erection of fish ways at Great Falls, Potomac River	348				3532
Erie Harbor, Pa., improvement of	297			2789	
Erie Harbor, Pa., preservation and protection of peninsula at Presque Isle	298			2799	
Erie, Lake, water-level observations for	351				3583
Escambia and Conecuh rivers, Fla. and Ala., improvement of	161		1634		
Essex Branch, Crane and Waters rivers of, Mass., examination and survey of	38	517			
Estimates for Engineer Depot for fiscal year 1891-'92	12				
Estimates for Mississippi River Commission for fiscal year 1891-'92	330				
Estimates for Missouri River Commission for fiscal year 1891-'92	331				
Estimates for river and harbor improvements	12				
Estimates for sea-coast defenses for fiscal year 1891-'92	5				
Estimates for supervision of New York Harbor for fiscal year 1891-'92	330				
Estimates for surveys and reconnaissances	355				
Eva Hemingway (pungy), removal of wreck of	101	942			
Evansville and Indianapolis Railroad Company, bridge of, over White River, Ind	341				
Evansville and Terre Haute Railroad Company, bridge of, over White River, Ind	341				
Examinations and surveys	13				
Explorations and reconnaissances	354				3560
Express (steamer), removal of wreck of boiler of	942				

Subject.	Page. Part I.		Part II.	Part III.	Part IV.
F.					
Fair Bluff, N. C., bridge over Lumber River at	343				
Fairlee Creek, Md., improvement of	99	936			
Fairport Harbor, Ohio, improvement of	295		1737	2781	
Falia, Bogue, La., improvement of	175				
Falls of the Ohio River, Indiana Chute, improvement of	230			2215	
Falls of the Ohio River, Louisville, Ky., improvement of	229			2211	
Farmer's and West Liberty, Licking River, Ky., between, improvement of	238			2273	
Feather and Sacramento rivers, Cal., improvement of	314		1545		2912
Fernandina Harbor, Fla., establishment of harbor-lines in	334		1179		
Fishing Creek, N. C., examination and survey of	133				
Fish-ways at Great Falls, Potomac River, erection of	348				3532
Fitchburg Railroad Company, bridge of, over Charles River, Mass	340				
Five Mile River Harbor, Conn., improvement of	58	646	1637		
Flint River, Ga., improvement of	161				
Florence, Ala., bridge over Tennessee River at	339				
Flushing Bay, N. Y., improvement of	62	664			
Fond du Lac River, in Lake Winnebago, Wis., harbor at mouth of, examination and survey of	259			2389	
Forked Deer River, Tenn., improvement of	194			1906	
Fortifications	4				
Fortifications, preparation of plans for	5				
Fortifications, protection, preservation, and repair of	4				
Fortifications, purchase of land for sites of	5				
Fort Smith, Ark., bridge over Arkansas River near	338				
Fourche River, Ark., improvement of	199			1941	
Fox River, Wis., operating and care of locks and dams on	258			2378	
Fox and Wisconsin rivers, Wis., improvement of	257			2365	
Fox and Wisconsin rivers, Wis., use of water-power on					3494
Frankfort, Ky., bridge of city of, over Kentucky River	342				
Frankfort, Ky., bridges over Kentucky River at	342				
Frankfort Harbor, Mich., improvement of	265			2612	
French Broad River, Tenn., improvement of	219			2127	
Fulton, Ark., Red River above, improvement of	195			1925	
Fulton and Vienna, Tombigbee River, Miss. and Ala., between, improvement of	170		1701		
Fulton and Walker's Bridge, Tombigbee River, Miss., between, improvement of	170		1700		
G.					
Galleries, cable	5				
Galveston Bay, bar at mouth of Cedar Bayou, Tex., examination and survey of	186		1815 1797		
Galveston Bay, Tex., ship-channel in, improvement of	183		1767		
Galveston Harbor, Tex., entrance to, improvement of	182				
Gartside, Benjamin (schooner), removal of wreck of	50	585			
Gasconade River, Mo., improvement of	205			1989	
Gauging Columbia River, Oregon	329				3064
Gauging Mississippi River and its principal tributaries	194			1908	
Gauging Mississippi River at St. Paul, Minn	215			2099	
Gauley River, W. Va., improvement of	234		1165	2248	
Georgetown Harbor, S. C., improvement of	132				
Glen Cove Harbor, N. Y., improvement of	61	662			
Gloucester Harbor, Mass., improvement of	30	491			
Gooseberry River, Lake Superior, Minn., survey of reef near mouth of	350				3583
Gordon's Landing, Lake Champlain, Vt., breakwater at, construction of	307			2877	
Governor's Island, New York Harbor, sea-wall at	5	383			
Gowanus Bay, N. Y., improvement of	70	727			
Grand Haven Harbor, Mich., improvement of	270			2646	
Grand Isle and North Hero, Vt., bridge of towns of, between North and South Hero Islands, Lake Champlain	336				
Grand Marais, Mich., harbor of refuge at, improvement of	246			2303	
Grand Marais Harbor, Minn., improvement of	241			2282	
Grand River, Mich., survey of				2676	
Grand Trunk Railway Company, bridge of, over channel to Back Cove, Portland, Me	343				
Grass River, at Massena, N. Y., improvement of	306			2874	
Grassy Point, Minn., bridge over St. Louis River from	342				
Great Falls, Potomac River, erection of fish-ways at	348				3532
Great Kanawha River, W. Va., improvement of	232			2237	
Great Kanawha River, W. Va., operating and care of locks and dams on	233			2246	
Great Kanawha River, W. Va., use of piers in					3492
Great Pee Dee River, S. C., improvement of	138		1215		

Subject.	Page. Part I.	Part II.	Part III.	Part IV.
Great Sodus Harbor, N. Y., improvement of	303		2855	
Great Wicomico River, Va., wreck at mouth of Cockle's Creek, removal of	121	1085		
Green and Barren rivers, Ky., operating and care of locks and dams on	237		2255	
Green Bay, Menomonee Harbor, Wis., from, to N. Ludington & Co.'s mill, examination and survey of	259		2394	
Green Bay Harbor, Wis., improvement of	250		2334	
Greenbrier River, W. Va., New River from mouth of Wilson River, Va., to mouth of, improvement of	235		2249	
Green Jacket Shoal, Providence River, R. I., removal of	45 571			
Greenport Harbor, N. Y., improvement of	61 660			
Grosse Pointe Channel, Mich., improvement of	285		2740	
Grosse Pointe, Detroit River at, Mich., examination and survey of	289		2749	
Gulf of Mexico, deep harbor on northwest coast of		1781		
Guyandotte River, W. Va., improvement of	239		2276	
H.				
Hampton Roads, Va., defenses at	4			
Hampton Roads, Va., wreck in Chesapeake Bay in channel between Cape Henry and, removal of	108 1029			
Handkerchief light-ship, wreck near, removal of	50 585			
Hannibal Bridge Company, bridge of, over Mississippi River	338			
Hannibal, Mo., bridge over Mississippi River above	338			
Harbor improvements, river and	12			
Harbor lines	13 331			
Harbor lines in Boston Harbor, Mass., establishment of	331 532			
Harbor lines in Fernandina Harbor, Fla., establishment of	334	1545		
Harbor lines in Hudson River, N. Y., from Troy to New Baltimore, establishment of	332 766			
Harbor lines in James River, Va., from Richmond to City Point, establishment of	333 1012			
Harbor lines in New York Harbor and adjacent waters, establishment of	332 786			
Harbor lines in Norfolk and Portsmouth harbors, Va., and adjacent waters, establishment of	333 1030			
Harbor lines in Portage Lake, Mich., establishment and maintenance of	246		2323	
Harbor lines in Quincy Bay, Ill., establishment of	334		2010	
Harbor lines in front of San Diego and Coronado, Cal., establishment of	334			2904
Harbor lines in San Francisco Harbor and adjacent waters, Cal., establishment of	334			2890
Harbor lines in Stamford Harbor, Conn., establishment of	332 682			
Harbor of refuge at Block Island, R. I., improvement of	47 575			
Harbor of refuge at Grand Marais, Mich., improvement of	246		2303	
Harbor of refuge at Hyannis, Mass., improvement of	38 552			
Harbor of refuge on Lake Pepin at Stockholm, Wis	209		2072	
Harbor of refuge at Little Harbor, N. H., improvement of	25 454			
Harbor of refuge at Milwaukee Bay, Wis., construction of	254		2351	
Harbor of refuge at Nantucket, Mass., improvement of	39 554			
Harbor of refuge at Petoskey Harbor, Mich., examination and survey for	274		2668	
Harbor of refuge at Portage Lake, Mich., construction of	266		2613	
Harbor of refuge at Sand Beach, Lake Huron, Mich	281		2729	
Harbor of refuge at Sandy Bay, Cape Ann, Mass., improvement of	29 488			
Harbor of refuge at Stonington, Conn., improvement of	49 581			
Harbor of refuge at entrance of Sturgeon Bay Canal, Wis	250		2336	
Harlem River, N. Y., bridges obstructing	344			3484
Harlem River, N. Y., improvement of	65 705			
Harlowe River, N. C., improvement of		1127		
Hartford, Conn., Connecticut River above, improvement of	52 606			
Hartford, Conn., Connecticut River below, improvement of	52 608			
Havre de Grace, Md., Susquehanna River above and below, improvement of	98 934			
Hawkinsville, Ga., bridges over Ocmulgee River at	143			
Hay Lake Channel, St. Mary's River, Mich., improvement of	277		2714	
Hazleton, Ind., bridge over White River near	341			
Hell Gate and East River, N. Y., removal of obstructions in	66 713			
Hell Gate and East River, N. Y., use of dike in				3491
Hemingway, Eva (pungy), removal of wreck of	101 942			
Hempstead Harbor, N. Y., wreck in, removal of	62 667			
Herr's Island, Allegheny River, Pa., dam at, construction of	227		2198	
Hiawassee River, Tenn., improvement of	220		2130	
Hill's Landing and Benedict, Patuxent River between, Md., improvement of	111	1060		
Hingham Harbor, Mass., improvement of	34 506			

Subject.	Page. Part. I.	Part II.	Part III.	Part IV.
Holmes River, La Grange Bayou, Fla., improvement of	158	1625		
Holton, Anna A. (schooner), removal of wreck of	37 516			
Hooper's Strait, Chesapeake Bay, wreck near, removal of	942			
Housatonic River, Conn., improvement of	56 631			
Hudson River, N. Y., improvement of	63 688			
Hudson River, N. Y., use of piers in				3489
Hudson River, N. Y., from Troy to New Baltimore, establishment of harbor lines in	332 766			[illegible]
Humboldt Harbor and Bay, Cal., improvement of	316			2918
Huron Harbor, Ohio, improvement of	293		2772	
Huron, Lake, Sand Beach, Mich., harbor of refuge at	281		2729	
Huron, Lake, Sand Beach, Mich., harbor of refuge at, injury of breakwater				3498
Hyannis, Mass., harbor of refuge at, improvement of	38 552			
I.				
Ice-harbor at head of Delaware Bay, Del., construction of	89 887			
Ice-harbor at Marcus Hook, Pa., construction of	88 886			
Ice-harbor at mouth of Muskingum River, Ohio, construction of	227		2198	
Ice-harbor at New Castle, Del., construction of	94 921			
Illinois and Mississippi Canal, location of	263		2580	
Illinois River, Ill., improvement of	261		2407	
Illinois River, Ill., operating and care of La Grange Lock	262		2574	
Illinois River and Des Moines Rapids, Mississippi River between, improvement of	206		2005	
Illinois River to Lake Michigan, water-way from, survey of			2419	
Illinois and Ohio rivers, Mississippi River between, improvement of	203		1964	
Il Salvatore (bark), removal of wreck of	92 905			
Increasing water supply of Washington, D. C	348			3531
Indiana Chute, Falls of the Ohio River, improvement of	230		2215	
Individuals, occupation or injury of piers, breakwaters, etc., by corporations or	13 344			3489
Injury of public works, piers, breakwaters, etc., by corporations or individuals	13 344			3489
Inland water-way between Beaufort Harbor and New River, N. C., improvement of	127	1138		
Inland water-way from Chincoteague Bay, Va., to Delaware Bay, near Lewes, Del., improvement of	97 930			
Inland water-way between New Berne and Beaufort, N. C., improvement of	125	1127		
Inspection of improvements at South Pass of Mississippi River	14 175	1725		
Ipswich River, Mass., improvement of	29 487			
Irondequoit Bay and Lake Ontario, channel between, report on			2853	
Ivey Bluff, N. C., bridge over Lumber River at	343			
J.				
Jackson, Miss., Pearl River below, improvement of	174	1714		
Jackson and Carthage, Pearl River, Miss., between, improvement of	173	1713		
James River, Va., improvement of	103 992			
James River, Va., from Richmond to City Point, establishment of harbor-lines in	333 1012			
Jefferson, Tex., and Shreveport, La., Cypress Bayou and the lakes between, improvement of	195		1826, 1914	
Jeffersonville, Ind., bridge over Ohio River at	335			3465
Jekyl Creek, Ga., improvement of	146	1420		
Jesse W. Knight (schooner), removal of wreck of	101 942			
John E. Sanford (schooner), removal of wreck of	37 516			
Johnsonville, Tenn., bridge over Tennessee River at	340			
Jones' Landing and Crumpton, Chester River between, Md., examination and survey of	102 954			
Joy (schooner), removal of wreck of	296		2787	
K.				
Kansas and Arkansas Valley Railway Company, bridge of, over Arkansas River	338			
Kansas City, Arkansas and New Orleans Railway Company bridge of, over Arkansas River	337			
Kedge's Strait, Chesapeake Bay, wreck near, removal of	942			
Kennebec River, Me., improvement of	20 442			
Kennebunk River, Me., examination and survey of	26 471			
Kennebunk River, Me., improvement of	23 449			
Kenosha Harbor, Wis., improvement of	256		2360	
Kentucky River, bridges obstructing	342			

Subject.	Page. Part I.		Part II.	Part III.	Part IV.
Kentucky River, Ky., improvement of	237			2261	
Kentucky River, Ky., operating and care of locks and dams on	238			2266	
Kentucky River at Frankfort, Ky., bridges over	342				
Kentucky River at Worthville, Ky., bridges over	342				
Keokuk and Hamilton Bridge Company, bridge of, over Mississippi River	339				
Keokuk, Iowa, bridge over Mississippi River at	339				
Kewaunee Harbor, Wis., improvement of	251			2340	
Keyport Harbor, N. J., improvement of	83	863			
Key West Harbor, Fla., northwest entrance, improvement of	150		1578		
Klaskuine River, Oregon, examination and survey of	324				2989
Knight, Jesse W. (schooner), removal of wreck of	101	942			
L.					
La Crosse, Wis., bridge of city of, over Mississippi River	336				
La Fourche Bayou, La., improvement of	177		1742		
La Grange Bayou, Fla., improvement of	158		1625		
La Grange Lock, Illinois River, operating and care of	262			2574	
Lake Champlain, bridge between North and South Hero islands, Vt	336				
Lake Champlain, channel between North and South Hero islands, Vt., improvement of	307			2876	
Lake Champlain, narrows at, N. Y. and Vt., improvement of	309			2883	
Lake Erie, water-level observations for	351				3583
Lake Huron, Sand Beach, Mich., harbor of refuge at	281			2729	
Lake Huron, Sand Beach, Mich., harbor of refuge at, injury to breakwater					3499
Lake Michigan to Illinois River, water-way from, survey of				2419	
Lake Ontario and Irondequoit Bay, N. Y., channel between, report on				2853	
Lake Pepin, at Stockholm, Wis., harbor of refuge on	209			2072	
Lake Superior, Minnesota Point, Superior, Wis., at west end of, examination and survey of	247			2306	
Lake Superior, survey of reef near mouth of Gooseberry River, Minn	350				3583
Lake Winnebago, Wis., harbor at mouth of Fond du Lac River, examination and survey of	259			2389	
Lakes between Jefferson, Tex., and Shreveport, La., improvement of	195			1826, 1914	
Lakes, Northern and Northwestern, printing and distribution of charts of	351				3588
Lakes, Northern and Northwestern, survey of	350				3583
Land for sites of fortifications, purchase of	5				
Larchmont Harbor, N. Y., examination and survey of	63	675			
La Salle, Ill., Illinois River at, to Lake Michigan, water-way from, survey of				2419	
Laurel, Del., bridge over Broad Creek near	335				
Laws affecting Corps of Engineers, 51st Congress, 1st session					3607
Legislation, proposed, to facilitate collection of commercial statistics	14				
Leonardtown, Md., Breton Bay, improvement of	112		1062		
Lewes, Del., Delaware Bay near, and Chincoteague Bay, Va., waterway between, improvement of	97	930			
Lewes, Del., pier in Delaware Bay near, construction of	89	888			
Licking River, Ky., from Farmer's to West Liberty, improvement of	238			2273	
Little Harbor, N. H., harbor of refuge at, improvement of	25	454			
Little Harbor, Woods Holl, Mass., wreck in, removal of	50	584			
Little Kanawha River, W. Va., improvement of	240			2278	
Little Pee Dee River, S. C., improvement of	138		1212		
Little Red River, Ark., improvement of	196			1927	
Little River, La., improvement of	189			1881	
Little River, Mo. and Ark., improvement of	202			1956	
Little Sodus Harbor, N. Y., improvement of	303			2858	
Livingston Point, Ky., improvement of				2183	
Location of Illinois and Mississippi Canal	263			2580	
Locations of proposed bridges over navigable waters, examination of plans and	13	335			
Lock, La Grange, Illinois River, operating and care of	262			2574	
Lock and dam No. 7, Monongahela River, purchase of	226			2193	
Locks and dams on Coosa River, Ga. and Ala., operating and care of	167		1658		
Locks and dams on Fox River, Wis., operating and care of	258			2378	
Locks and dams on Great Kanawha River, W. Va., operating and care of	233			2246	
Locks and dams on Green and Barren rivers, Ky., operating and care of	237			2255	
Locks and dams on Kentucky River, Ky., operating and care of	238			2268	
Locks and dams on Monongahela River, W. Va. and Pa., operating and care of	226			2192	

Subject.	Page. Part I.		Part II.	Part III.	Part IV.
Locks and dams on Muskingum River, Ohio, operating and care of	228			2201	
Louisville and Jeffersonville Bridge Company, bridge of, over Ohio River	335				3465
Louisville and Nashville Railroad Company, bridges of, over Kentucky River	342				
Louisville and Portland Canal, operating and care of	230			2221	
Louisville, Ky., bridge over Ohio River at	335				3465
Louisville, Ky., Falls of the Ohio River, improvement of	229			2211	
Lowell Canal, Muskingum River, Ohio, bridge over	341				
Lower Cumberland River, Tenn., from Nashville to its mouth, examination and survey of	223			2151	
Lower Willamette and Columbia rivers, below Portland, Oregon, improvement of	327				3058
Lubec Channel, Me., improvement of	15	428			
Ludington Harbor, Mich., improvement of	267			2621	
Lumber City, Ga., bridge over Ocmulgee River near	343				
Lumber River, N. C., bridges obstructing	343				
Lumber River, N. C., improvement of	135		1198		
Lumber River, at Fair Bluff, N. C., bridge over	343				
Lumber River, at Ivey Bluff, N. C., bridge over	343				
Lumber River, at Matthews' Bluff, N. C., bridge over	343				
Lumber River, at Phillips', N. C., bridge over	343				
Lumber River, at Princess Ann, N. C., bridge over	343				
Lynn Harbor, Mass., improvement of	31	494			
Lyons and Fulton Bridge Company, bridge of, over Mississippi River	337				
Lyons, Iowa, bridge over Mississippi River near	337				
M.					
Macon, Ga., bridges over Ocmulgee River below	343				
Macon Bayou and Tensas River, La., improvement of	190			1888	
Manatee River, Fla., improvement of	152		1602		
Manchester Harbor, Mass., improvement of	31	493			
Manistee Harbor, Mich., improvement of	266			2616	
Manistique Harbor, Mich., improvement of	247			2326	
Manitowoc Harbor, Wis., improvement of	252			2343	
Manokin River, Md., examination and survey of	102	909			
Mantua Creek, N. J., improvement of	91	954			
Maple Leaf (steamer), removal of obstructions at site of wreck of	156		1614		
Maps, military and other	353				
Maps of battle-fields	354				
Marcus Hook, Pa., ice-harbor at, construction of	88	886			
Marquette Harbor, Mich., improvement of	245			2300	
Martha's Vineyard, inner and outer harbor at Edgartown, Mass., examination and survey of	50	585			
Massena, N. Y., Grass River at, improvement of	306			2874	
Mattaponi River, Va., improvement of	116		1072		
Matthews' Bluff, N. C., bridge over Lumber River at	343				
Maurice River, N. J., improvement of	92	916			
Memphis and Charleston Railroad Company, bridge of, over Tennessee River	339				
Menomonee Harbor, Mich. and Wis., improvement of	248			2328	
Menomonee Harbor, Wis., from Green Bay to N. Ludington & Co.'s mill, examination and survey of	259			2394	
Merrimac River, Mass., improvement of	27	484			
Mexico, Gulf of, deep harbor on northwest coast of			1781		
Michigan City, Ind., bridge of city of, over Trail Creek	338				
Michigan City Harbor, Ind., inner harbor, improvement of	274			2662	
Michigan City Harbor, Ind., outer harbor, improvement of	273			2662	
Michigan Lake to Illinois River, water-way from, survey of				2419	
Milford Harbor, Conn., improvement of	55	626			
Military divisions and departments, reconnaissances and explorations in	354				3599
Military maps	353				
Mill Creek, Fort Monroe, Va., bridge over	9	387			
Milwaukee Bay, Wis., harbor of refuge at, construction of	254			2351	
Milwaukee Harbor, Wis., improvement of	254			2353	
Mingo Creek, S. C., improvement of	135		1200		
Minneapolis, Minn., and Des Moines Rapids, Mississippi River between, improvement of	208			2033	
Minnesota Point, at Superior, at west end of Lake Superior, Wis., examination and survey of	247			2306	
Minnesota River, Minn., improvement of	213			2090	
Mispillion Creek, Del., improvement of	96	927			
Missisquoy Bay, Vt., bridge obstructing	343				
Mississippi Canal, Illinois and, location of	263			2580	
Mississippi River, annual report of Mississippi River Commission on improvement of	330				3083

Subject.	Page. Part I.	Part II.	Part III.	Part IV.
Mississippi River, bridges obstructing	338			
Mississippi River, Des Moines Rapids, improvement of	208		2060	
Mississippi River, between Des Moines Rapids and Illinois River, improvement of	206		2005	
Mississippi River, discharge observations at Arkansas City, Ark				3165
Mississippi River, discharge observations at Helena, Ark				3158
Mississippi River, discharge observations near New Madrid, Mo				3150
Mississippi River, discharge observations at Wilsons Point, La., and at break in Skipwith Levee, Miss				3170
Mississippi River, gauging, and its tributaries	194		1908	
Mississippi River, gauging, at St. Paul, Minn	215		2099	
Mississippi River above Hannibal, Mo., bridge over	338			
Mississippi River at Keokuk, Iowa, bridge over	339			
Mississippi River at La Crosse, Wis., bridge over	336			
Mississippi River, near Lyons, Iowa, bridge over	337			
Mississippi River, from Minneapolis to Des Moines Rapids, improvement of	208		2033	
Mississippi River at Muscatine, Iowa, bridge over	336			
Mississippi River at New Orleans, La., bridges over	13			3449 3453
Mississippi River, between the Ohio and Illinois rivers, improvement of	203		1964	
Mississippi River, regimen elements				3119
Mississippi River, relation between mean bank height and mean high water				3137
Mississippi River, removing snags and wrecks from	203		1959	
Mississippi River, reservoirs at headwaters of	211		2080	
Mississippi River above St. Anthony Falls, Minn., improvement of	210		2077	
Mississippi River, South Pass of, inspection of improvements at	14 175	1725		
Mississippi River, survey of				3179
Mississippi River, surveys for reservoirs at sources of	215		2098	
Mississippi River, Upper, operation of snag-boats and dredge-boats on	207		2021	
Mississippi River Commission, annual report for fiscal year ending June 30, 1890	330			3083
Mississippi River Commission, general service				3185
Mississippi River Commission, memorandum on outlets				3105
Mississippi River Commission, memorandum on question whether levees cause river-beds to rise				3093
Mississippi River Commission, note on flood report of 1890				3107
Mississippi River Commission, report of secretary, assistant to construction committee				3112
Mississippi River Commission, report on operations in first district				3196
Mississippi River Commission, report on operations in second district				3211
Mississippi River Commission, report on operations in third district				3228
Mississippi River Commission, report on operations in fourth district				3289
Mississippi River Commission, statement of length and distribution of front levees				3111
Missouri, Division of the, report of engineer officer on operations in	355			3600
Missouri, Kansas and Texas Railway Company, bridge of, over Mississippi River	339			
Missouri Pacific Railway Company, bridge of, over Mississippi River	339			
Missouri River, annual report of Missouri River Commission on improvement of	331			3361
Missouri River at Bellefontaine Bluffs, below St. Charles, Mo., bridge over	337			
Missouri River, dates of ice closings and openings				3392
Missouri River, descriptions and elevations of bench-marks				3393
Missouri River at Nebraska City, Nebr., bridge over	337			
Missouri River at Omaha, Nebr., bridge over	337			
Missouri River near Sioux City, Iowa, bridge over	338			
Missouri River Commission, annual report for fiscal year ending June 30, 1890	331			3361
Missouri River Commission, annual report of Lieut. H. M. Chittenden				3419
Missouri River Commission, annual report of Mr. S. Waters Fox, division engineer				3428
Missouri River Commission, annual reports of Mr. Charles F. Potter, division engineer				3422 3387
Missouri River Commission, annual report of secretary				
Missouri River Commission, annual report of Mr. S. H. Yonge, division engineer				34
Missouri River Commission, report of Mr. G. A. Marr, assistant engineer				

Subject.	Page. Part I.		Part II.	Part III.	Part
Missouri River Commission, report of Mr. O. B. Wheeler, assistant engineer					
Missouri River Commission, report on borings					
Missouri River Commission, report on commerce during 1889					
Mobile Harbor, Ala., improvement of	168		1692		
Mokelumne River, Cal., improvement of	314				
Monongahela River, W. Va. and Pa., improvement of	226			2190	
Monongahela River, W. Va. and Pa., operating and care of locks and dams on	226			2192	
Monongahela River, purchase of Lock and Dam No. 7	226			2193	
Monroe, Fort, Va., artesian well at	5				
Monroe, Fort, Va., bridge over Mill Creek at	9	387			
Monroe, Fort, Va., shore protection at	5				
Monroe, Fort, Va., wharf at	9	385			
Monroe Harbor, Mich., improvement of	289			2753	
Montgomery, Ala., bridge over Alabama River near	336				
Montgomery, Tuscaloosa and Memphis Railway Company, bridge of, over Alabama River	336				
Monument, Washington, Washington, D. C., care and maintenance of	349				
Moodna Creek, Cornwall, N. Y., bridge obstructing	342				
Moose-a-bec Bar, Me., improvement of	15	428			
Mormon Slough, San Joaquin River, Cal., improvement of	313				
Mount Desert to Porcupine Island, Me., breakwater from, construction of	16	430			
Mount Vernon, Ga., bridge over Oconee River, near	344				
Mount Vernon, Va., to Aqueduct Bridge, D. C., survey of road from	350				
Mount Vernon, Va., channel at, Potomac River, improvement of	112		1061		
Murderer's Creek, Cornwall, N. Y., bridge obstructing	342				
Muscatine Bridge Company, bridge of, over Mississippi River	336				
Muscatine, Iowa, bridge over Mississippi River at	336				
Muskegon Harbor, Mich., improvement of	269			2636	
Muskingum County, Ohio, bridges of, over Muskingum River	336	341			
Muskingum River, Ohio, bridges obstructing	341				
Muskingum River, Ohio, improvement of	228			2200	
Muskingum River, Ohio, operating and care of lock and dams on	228			2201	
Muskingum River, between Beverly and Waterford, Ohio, bridge over	341				
Muskingum River, at Brush Creek, about 5 miles below Zanesville, Ohio, bridge over	336				
Muskingum River, ice-harbor at mouth of, construction of	227			2198	
Muskingum River, Lowell Canal, Ohio, bridge over	341				
Muskingum River at Zanesville, Ohio, bridges over	336	341			
N.					
Nansemond River, Va., improvement of	106	1024			
Nantucket, Mass., harbor of refuge at, improvement of	39	554			
Napa River, Cal., improvement of	309				288
Narragansett Bay, at mouth of Narrow River, R. I., examination and survey of	51	595			
Narragansett Bay and Providence River, R. I., improvement of	44	568			
Narraguagus River, Me., improvement of	16	429			
Narrow River, Narragansett Bay at mouth of, R. I., examination and survey of	51	595			
Narrows at Lake Champlain, N. Y. and Vt., improvement of	309			2883	
Nashville and Knoxville Railroad Company, bridge of, over Caney Fork River, Tenn	337				
Nashville, Chattanooga and St. Louis Railway Company, bridge of, over Tennessee River	340				
Nashville, Tenn., Cumberland River above, improvement of	222			2136	
Nashville, Tenn., Cumberland River below, improvement of	221			2134	
Nashville, Tenn., Lower Cumberland River below, examination and survey of	223			2151	
Navigation, obstruction of, by bridges	13	338			
Nebraska Central Railway Company, bridge of, over Missouri River	337				
Nebraska City, Nebr., bridge of city of, over Missouri River	337				
Neches River, Tex., improvement of	181		1753		
Nehalem Bay and Bar, Oregon, examination and survey of	324				2983
Neuse River, N. C., improvement of	124		1122		
Neva (brig), removal of wreck of	156		1614		
Newark, N. J., Passaic River above, improvement of	78	848			
Newark, N. J., Passaic River below, improvement of	79	849			
Newark Bay, N. J., use of dike in					3493
New Baltimore and Troy, N. Y., Hudson River between, establishment of harbor lines in	332	756			
New Bedford Harbor, Mass., improvement of	44	560			
New Berne and Beaufort, N. C., inland waterway between, improvement of	125		127		

Subject.	Page. Part I.		Part II.	Part III.	Part IV.	
Newburyport Harbor, Mass., improvement of	27	482				
Newburyport Harbor, Mass., wreck in, removal of	37	516				
New Castle, Del., ice-harbor at, construction of	94	921				
New Haven Harbor, Conn., improvement of	54	617				
New Haven Harbor, Conn., breakwater at, construction of	54	622				
New Jersey and Staten Island, channel between, improvement of	77	846				
New London Harbor, Conn., improvement of	51	604				
New Orleans, La., bridges over Mississippi River at	13				3449	3453
New Orleans, Natchez and Fort Scott Railway Company, bridge of, over Tensas River, La	337					
Newport Harbor, R. I., improvement of	46	572				
Newport River, N. C., improvement of			1127			
New River, N. C., improvement of	128		1141			
New River and Beaufort Harbor, N. C., inland water-way between, improvement of	127		1138			
New River from mouth of Wilson River, Va., to mouth of Greenbrier River, W. Va., improvement of	235			2249		
New Rochelle, Echo Harbor, N. Y., improvement of	60	652				
New Rochelle Harbor, N. Y., improvement of	60	654				
Newtown Creek, N. Y., improvement of	68	720				
New York and Harlem Railroad Company, bridge of, over Harlem River, N. Y	344					
New York Central and Hudson River Railroad Company, bridge of, over Harlem River, N. Y	344					
New York Central and Hudson River Railroad Company, bridge of, over Moodna or Murderer's Creek, N. Y	342					
New York, N. Y., bridge of city of, over Harlem River	344					
New York, N. Y., bridges over Harlem River at	344					3484
New York, N. Y., defenses of	4					
New York, N. Y., removal of ledge from Broome street to Twenty-third street, East River, examination and survey for	74	761				
New York Harbor, N. Y., improvement of	71	732				
New York Harbor, N. Y., and adjacent waters, establishment of harbor lines in	332	786				
New York Harbor, N. Y., Buttermilk Channel, improvement of	69	724				
New York Harbor, N. Y., Gowanus Bay, improvement of	70	727				
New York Harbor, N. Y., sea-wall at David's Island	5	382				
New York Harbor, N. Y., sea-wall at Governor's Island	5	383				
New York Harbor, N. Y., supervision of	330					3077
Niagara, Fort, preservation of site of, and sea-wall at	5					
Niagara River and Tonawanda Harbor, N. Y., improvement of	299			2839		
Nomini Creek, Va., improvement of	113		1063			
Nootsack River, Wash., improvement of	323					2986
Norfolk Harbor and its approaches, Va., improvement of	104	1021				
Norfolk Harbor and navy-yard, Va., approach to, between Lambert's Point and Fort Norfolk, improvement of	105	1023				
Norfolk and Portsmouth harbors, Va., and adjacent waters, establishment of harbor lines in	333	1030				
North East River, Md., examination and survey of	102	951				
North East River (Cape Fear), N. C., examination and survey of	133		1181			
Northern and Northwestern Lakes, printing and distribution of charts of	351					3588
Northern and Northwestern Lakes, survey of	350					3583
North Hero and Grand Isle, Vt., bridge of towns of, between North and South Hero islands, Lake Champlain	336					
North Hero and South Hero islands, Lake Champlain, Vt., bridge between	336					
North Hero and South Hero islands, Lake Champlain, Vt., channel between, improvement of	307			2876		
North Landing River, Va. and N. C., improvement of	107	1027				
North River Bar, Currituck Sound, and Coanjok Bay, N. C., improvement of	108	1027				
Northwestern and Northern Lakes, printing and distribution of charts of	351					3588
Northwestern and Northern Lakes, survey of	350					3583
Norwalk Harbor, Conn., improvement of	57	643				
Noxubee River, Miss., improvement of	171		1704			
O.						
Oakland Harbor, Cal., improvement of	310					2886
Oak Orchard Harbor, N. Y., improvement of	301			2847		
Observations, water-level, for Lake Erie	351					3583
Occoquan Creek, Va., examination and survey of	121		1089			
Occupation or injury of public works, piers, breakwaters, etc., by corporations or individuals	13	344				3450
Ocmulgee River, Ga., bridges obstructing	343					
Ocmulgee River, Ga., examination and survey of	147		1455			

Subject.	Page. Part I.		Part II.	Part III.	Pa
Ocmulgee River, Ga., improvement of	145		1395		
Ocmulgee River, at Hawkinsville, Ga., bridges over	343				
Ocmulgee River, near Lumber City, Ga., bridge over	343				
Ocmulgee River, below Macon, Ga., bridges over	343				
Oconee River, Ga., examination and survey of	147		1430		
Oconee River, Ga., improvement of	144		1388		
Oconee River, near Mount Vernon, Ga., bridge obstructing	344				
Oconto Harbor, Wis., improvement of	249			2330	
Office of the Chief of Engineers	356				
Officers of the Corps of Engineers	3				
Officers of the Corps of Engineers, statement of rank and duties of	358				
Ogdensburg Harbor, N. Y., improvement of	305			2871	
Ohio River, improvement of	224			2164	
Ohio River, about 1¼ miles above Big Sandy River and about 1 mile below Ceredo, W. Va., bridge over	337				
Ohio River, Davis Island Dam, operating and care of	226			2186	
Ohio River, Falls of the, improvement of	229			2211	
Ohio River, Falls of the, Indiana Chute, improvement of	230			2215	
Ohio River, between Jeffersonville, Ind., and Louisville, Ky., bridge over	335				
Ohio River, at Wheeling, W. Va., bridge over	336				
Ohio and Illinois rivers, Mississippi River between, improvement of	203			1964	
Olcott Harbor, N. Y., improvement of	301			2844	
Old Colony Railroad Company, bridge of, over Taunton River, Mass	340				
Omaha, Nebr., bridge over Missouri River at	337				
Onancock Harbor, Va., examination and survey of	102	968			
Ontario, Lake, and Irondequoit Bay, N. Y., channel between, report on				2853	
Ontonagon Harbor, Mich., improvement of	244			2297	
Operation of snag-boats and dredge-boats on Upper Mississippi River	207			2021	
Osage River, Mo., improvement of	205			1992	
Osage River, Mo., survey of	206			1995	
Oswego Harbor, N. Y., improvement of	304			2862	
Otter Creek, Vt., improvement of	308			2881	
Ouachita River, Ark., above Camden, improvement of	188			1878	
Ouachita and Black rivers, Ark. and La., improvement of	188			1871	
Owendaw and Wando rivers and other waters connecting Bull's Bay and Charleston Harbor, S. C., examination and survey of	141		1239		
P.					
Pacific, Division of the, report of engineer officer on operations in	355				
Pacific Short Line Bridge Company, bridge of, over Missouri River	338				
Pamlico and Tar rivers, N. C., improvement of	122		1112		
Pamunky River, Va., improvement of	117		1074		
Pamunky River, wreck at Skidmore's Bar, Va., removal of	121		1084		
Pascagoula River, Miss., improvement of	172		1706		
Passaic River, N. J., improvement of	78	848			
Passaic River, N. J., use of dike in					
Passaic River, N. J., above Newark, improvement of	78	848			
Passaic River, N. J., below Newark, improvement of	79	849			
Patapsco River, and channel to Baltimore, Md., improvement of	102	987			
Patriot (bark), removal of wreck of	92	905			
Patuxent River, Md., from Benedict to Hill's Landing, improvement of	111		1060		
Pawcatuck River, R. I. and Conn., improvement of	48	578			
Pawtucket River, R. I., improvement of	43	566			
Pearl River, Miss., between Edinburgh and Carthage, improvement of	173		1711		
Pearl River, Miss., between Jackson and Carthage, improvement of	173		1713		
Pearl River, Miss., below Jackson, improvement of	174		1714		
Pease River, Fla., improvement of	152		1600		
Peninsula at Presque Isle, Erie Harbor, Pa., preservation and protection of	298			2799	
Penobscot River, Me., improvement of	17	432			
Pensacola Harbor, Fla., improvement of	159		1627		
Pensaukee Harbor, Wis., improvement of	249			2833	
Pentwater Harbor, Mich., improvement of	268			2631	
Pepin, Lake, at Stockholm, Wis., harbor of refuge on	209			3072	
Perry County, Tenn., bridge over Tennessee River at	336				
Perryville, Tenn., bridge over Tennessee River at	336				
Petaluma Creek, Cal., improvement of	315				

Subject.	Page. Part I.		Part II.	Part III.	P
Petit Jean River, Ark., improvement of	198			1939	
Petoskey Harbor, Mich., examination and survey of	274			2668	
Pettingill, E. L. (bark), removal of wreck of	108	1029			
Philadelphia Harbor, Pa., improvement of	86	882			
Philadelphia, Wilmington and Baltimore Railroad Company, bridge of, over Broad Creek, Del	335				
Phillips', N. C., bridge over Lumber River at	343				
Pier in Delaware Bay, near Lewes, Del., construction of	89	888			
Piers, etc., occupation or injury of, by corporations or individuals	13	344			3489
Pig River and Brook Neal, Staunton River, Va., between, improvement of	120		1082		
Pine Lake, entrance to, and Charlevoix Harbor, Mich., improvement of	264			2610	
Plans and locations of proposed bridges over navigable waters, examination of	13	335			
Plans for fortifications, preparation of	5				
Plaquemine Bayou, La., improvement of	178		1746		
Plaquemine Bayou, La., securing mouth from further caving	182		1761		
Platte, Department of the, report of engineer officer on operations in	355				3601
Plattsburg Harbor, N. Y., improvement of	307			2878	
Pleasant River, from Columbia Falls to its mouth, Me., examination and survey of	26	467			
Plymouth Harbor, Mass., improvement of	35	510			
Point Judith, East, R. I., coast near life-saving station, examination and survey of	51	592			
Pollock Rip light-ship, wreck near, removal of	50	583			
Porcupine Island, Me., breakwater from Mount Desert to construction of	16	430			
Portage Lake, Mich., establishment and maintenance of harbor lines in	246			2323	
Portage Lake, Mich., harbor of refuge at, construction of	266			2613	
Port Chester Harbor, N. Y., improvement of	59	650			
Port Clinton Harbor, Ohio, improvement of	291			2767	
Portland, Oregon, Columbia and Lower Willamette rivers below, improvement of	327				3058
Portland, Oregon, Willamette River above, improvement of	328				3061
Portland Canal, Louisville and, operating and care of	230			2221	
Portland Harbor, Me., improvement of	21	444			
Portland Harbor, Me., channel in Back Cove, improvement of	21	445			
Portland Harbor, Me., bridge over channel leading to Back Cove	343				
Portsmouth Harbor, N. H., improvement of	24	450			
Portsmouth and Norfolk harbors, Va., and adjacent waters, establishment of harbor lines in	333	1030			
Port Washington Harbor, Wis., improvement of	253			2349	
Post of Willets Point, N. Y	10	389			
Potomac River, bridge over Eastern Branch, D. C., construction of	110		1048		
Potomac River, at Great Falls, erection of fish-ways at	348				3532
Potomac River, channel at Mount Vernon, Va., improvement of	112		1061		
Potomac River, at Washington, D. C., improvement of	108		1037		
Potomac River, at Washington, D. C., report on bridge over			1045		
Powow River, Mass., improvement of	28	485			
Presque Isle Peninsula, Erie Harbor, Pa., preservation and protection of	298			2799	
Princess Ann, N. C., bridge over Lumber River at	343				
Printing and distribution of charts of Northern and Northwestern Lakes	351				3588
Providence River, Green Jacket Shoal, R. I., removal of	45	571			
Providence River and Narragansett Bay, R. I., improvement of	44	568			
Provincetown Harbor, Mass., improvement of	36	513			
Provincetown Harbor, Mass., wreck in, removal of	37	516			
Public buildings and grounds, District of Columbia, improvement and maintenance of	349				3535
Public works, occupation and injury of, by corporations and individuals	13	344			3489
Pulaski County, Ga., bridge of, over Ocmulgee River	343				
Purchase of lock and dam No. 7, Monongahela River	226			2193	
Putnam County, Tenn., bridge over Caney Fork River at	337				
Q.					
Quilp (schooner), removal of wreck of	50	584			
Quincy Bay, Ill., establishment of harbor lines at	334			2010	
R.					
Racine Harbor, Wis., improvement of	255			2356	
Rahway River, N. J., improvement of	80	858			

Subject.	Page. Part I.		Part II.	Part III.	Part IV.
Randolph and Brook Neal, Staunton River, Va., between, improvement of	119		1081		
Rank and duties of officers of the Corps of Engineers, statement of	358				
Rappahannock River, Va., improvement of	114		1065		
Rappahannock River, Va., at Urbana Creek, improvement of	115		1070		
Raritan Bay, N. J., improvement of	72	753			
Raritan River, N. J., improvement of	81	855			
Reconnaissances and explorations	354				3499
Red River, La. and Ark., improvement of	186			1820	
Red River, above Fulton, Ark., improvement of	195			1925	
Red River, below Fulton, Ark., survey of				1830	
Red and Atchafalaya rivers, rectification of					3308
Red River of the North, Minn. and Dak., improvement of	214			2093	
Redwood Harbor, Cal., improvement of	311				2897
Reef near mouth of Gooseberry River, Lake Superior, Minn., survey of	350				3583
Removing obstructions in Arkansas River, Ark. and Kans	196			1928	
Removing obstructions in East River and Hell Gate, N. Y	66	713			
Removing snags and wrecks from Mississippi River	203			1959	
Reservoirs at headwaters of Mississippi River	211			2080	
Reservoirs at sources of Mississippi, St. Croix, Chippewa, and Wisconsin rivers, surveys for	215			2098	
Richmond and City Point, Va., James River between, establishment of harbor lines in	333	1012			
River and harbor improvements	12				
Road from Aqueduct Bridge, D. C., to Mount Vernon, Va., survey of	350				3563
Roads and bridges in Yellowstone National Park, construction and improvement of	352				3591
Roanoke River, N. C and Va., improvement of	121		1106		
Roanoke River, Va., between Clarksville and Eaton Falls, examination of	133		1175		
Robeson County, N. C., bridges of, over Lumber River	343				
Rockland Harbor, Me., improvement of	20	438			
Rockport, Tex., Aransas Pass and Bay up to, improvement of	185		1810		
Rockport Harbor, Me., improvement of	19	437			
Rogers, Ind., bridge over White River at	341				
Romley Marsh, Ga., improvement of	143		1367		
Rondout Harbor, N. Y., improvement of	64	701			
Rouge River, Mich., improvement of	288			2747	
Rouse's Point, Lake Champlain, N, Y., breakwater at, construction of	306			2875	
S.					
Sabine Pass, Tex., improvement of	181		1753		
Sabine River, La. and Tex., improvement of	180		1752		
Sackett's Harbor, N. Y., improvement of	305			2868	
Saco River, Me., improvement of	23	447			
Saco River, Me., breakwater at mouth of, construction of	22	446			
Sacramento River, mouth of Cal., etc., survey of	311				2890
Sacramento and Feather rivers, Cal., improvement of	314				2912
Saginaw River, Mich., improvement of	280			2724	
Saginaw River, Mich., injury to Carrollton revetment					3498
St. Anthony Falls, Minn., Mississippi River above, improvement of	210			2077	
St. Augustine Harbor, Fla., improvement of	149		1566		
St. Charles, Mo., bridge over Missouri River below	337				
St. Clair Flats Canal, Mich., improvement of	283			2737	
St. Clair Flats Canal, Mich., operating and care of	285			2739	
St. Cloud (barge), removal of wreck of	92	905			
St. Croix River, Me., examination and survey of	26	463			
St. Croix River, Wis. and Minn., improvement of	212			2087	
St. Croix River, Wis. and Minn., surveys for reservoirs at sources of	215			2098	
St. Francis, Ark., bridge over St. Francis River at	342				
St. Francis River, Ark., improvement of	201			1952	
St. Francis River, Mo., improvement of	202			1954	
St. Francis River at St. Francis, Ark., bridge obstructing	342				
St. Jerome's Creek, Md., harbor at entrance of, improvement of	114		1064		
St. John's River, Fla., improvement of	147		1549		
St. John's River, Fla., wreck in, removal of	156		1614		
St. John's River, wreck at Ward's Bank, at mouth of, Fla., removal of	156		1614		
St. Jones River, Del., improvement of	95	925			
St. Joseph Harbor, Mich., improvement of	272			2658	
St. Joseph River, Mich., improvement of	273			2661	
St. Joseph River, Mich., near its mouth, bridge obstructing	340				
St. Louis, Arkansas and Texas Railway Company, bridge of, over St. Francis River, Ark	342				

Subject.	Page. Part I.		Part II.	Part III.	Part IV.
St. Louis Bay, Wis., injury to channels in					3493
St. Louis Bay and Superior Bay, harbor at, Wis., improvement of	243			2291	
St. Louis, Keokuk and Northwestern Railroad Company, bridge of, over Missouri River	337				
St. Louis River, from Grassy Point, Minn., bridge obstructing	342				
St. Mary's Falls Canal, Mich., dry dock at	276			2714	
St. Mary's Falls Canal, Mich., injury to works					3498
St. Mary's Falls Canal, Mich., operating and care of	276			2695	
St. Mary's River, Mich., improvement of	275			2684	
St. Mary's River, Hay Lake Channel, Mich., improvement of	277			2714	
St. Paul and Duluth Railway Company, bridge of, over St. Louis River, Minn	342				
St. Paul, Minn., gauging Mississippi River at or near	215			2099	
Salem Harbor, Mass., examination and survey of	38	528			
Salkahatchie River, S. C., improvement of	137		1209		
Sand Beach, Lake Huron, Mich., harbor of refuge at	281			2729	
Sand Beach, Lake Huron, Mich., harbor of refuge at, injury of breakwater					3498
San Diego Harbor, Cal., establishment of harbor lines in	334				2904
San Diego Harbor, Cal., improvement of	313				2902
Sandusky City Harbor, Ohio, improvement of	291			2768	
Sandusky River, Ohio, improvement of	292			2771	
Sandy Bay, Cape Ann, Mass., harbor of refuge at, improvement of	29	488			
Sanford, John E. (schooner), removal of wreck of	37	516			
San Francisco, Cal., defenses of	4				
San Francisco Harbor and adjacent waters, Cal., establishment of harbor lines in	334				2890
San Francisco Harbor, Cal., etc., survey of	311				2890
San Joaquin River, mouth of, Cal., etc., survey of	311				2890
San Joaquin River, Stockton and Mormon sloughs, Cal., improvement of	313				2909
San Luis Obispo Harbor, Cal., improvement of	311				2899
San Pablo Bay, Cal., etc., survey of	311				2890
Santee River, S. C., improvement of	138		1218		
Sarah L. Simmons (schooner), removal of wreck of	50	583			
Sarasota Bay, Fla., examination and survey of	156		1615		
Saugatuck Harbor, Mich., improvement of	271			2654	
Saugerties Harbor, N. Y., improvement of	64	699			
Savannah, Americus and Montgomery Railway Company, bridge of, over Oconee River	344				
Savannah River, between Savannah and Augusta, Ga., improvement of	142		1324		
Savannah River, above Augusta, Ga., improvement of	143		1365		
Savannah River, above Augusta and between Augusta and Andersonville, examination and survey of	147		1484		
Savannah River and Harbor, Ga., improvement of	142		1246		
Sayville, Brown's Creek, N. Y., examination and survey of	63	639			
Schuylkill River, Pa., improvement of	87	884			
Scituate Harbor, Mass., improvement of	34	508			
Scottsburgh, Oregon, Umpqua River below, examination and survey of	324				3005
Sea-coast defenses	4				
Sea-wall at David's Island, New York Harbor	5	382			
Sea-wall at Fort Niagara, N. Y	5				
Sea-wall at Governor's Island, New York Harbor	5	383			
Sea-walls and earth embankments	5				
Shallotte River, N. C., examination and survey of	133		1184		
Sharp's Island, Chesapeake Bay, wreck near, removal of	101	942			
Sheboygan Harbor, Wis., improvement of	253			2346	
Sheepshead Bay, N. Y., improvement of	74	837			
Shenandoah River, W. Va., improvement of	111		1050		
Ship channel in Galveston Bay, Tex., improvement of	183		1797		
Shreveport, La., and Jefferson, Tex., Cypress Bayou and the lakes between, improvement of	195			1826, 1914	
Shrewsbury River, N. J., improvement of	83	860			
Simmons, Sarah L. (schooner), removal of wreck of	50	583			
Sioux City, Iowa, bridge over Missouri River near	338				
Sipsey River, Ala., from Tombigbee River at Vienna to Texas, examination and survey of	175		1722		
Sites for fortifications, purchase of	5				
Siuslaw River and Bar, Oregon, examination and survey of	324				2999
Skagit River, Wash., improvement of	323				2986
Skidmore's Bar, Pamunky River, Va., wreck at, removal of	121		1084		
Smith County, Tenn., bridge over Caney Fork River at	337				
Snag-boats and dredge-boats on Upper Mississippi River, operation of	207			2021	
Snags and wrecks, removing, from Mississippi River	203			1959	
Snake and Upper Columbia rivers, Oregon and Wash., improvement of	322				

Subject.	Page. Part I.		Part II.	Part III.	Part IV.
Snohomish River, Wash., improvement of	323				2986
Snoqualmie River, Wash., improvement of	323				2986
Somerset, Mass., bridge over Taunton River at	340				
South Fork of Cumberland River, Ky., improvement of	222			2148	
South Haven Harbor, Mich., improvement of	272			2656	
South Hero and North Hero islands, Lake Champlain, Vt., bridge between	336				
South Hero and North Hero islands, Lake Champlain, Vt., channel between, improvement of	307			2876	
South Pass of Mississippi River, inspection of improvements at	14	175	1725		
South River, Salem Harbor, Mass., examination and survey of	38	528			
South River, N. J., improvement of	82	858			
Stamford Harbor, Conn., establishment of harbor lines in	332	682			
Stamford Harbor, Conn., improvement of	58	648			
Staten Island and New Jersey, channel between, improvement of	77	846			
Statistics, commercial, proposed legislation to facilitate collection of	14				
Staunton River, Va., between Brook Neal and Randolph, improvement of	119		1081		
Staunton River, Va., between Pig River and Brook Neal, improvement of	120		1082		
Steele's Bayou, Miss., improvement of	193			1900	
Steilaquamish River, Wash., improvement of	323				2986
Stockholm, Wis., Lake Pepin, harbor of refuge at	209			2072	
Stockton Slough, San Joaquin River, Cal., improvement of	313				2909
Stonington, Conn., harbor of refuge at, improvement of	49	581			
Straits of Carquinez, Cal., etc., survey of	311				2890
Sturgeon Bay Canal, Wis., harbor of refuge at entrance of	250			2336	
Submarine mines	5				
Suisun Bay, Cal., etc., survey of	311				2890
Sumpawanus Inlet, N. Y., improvement of	75	841			
Superior, Wis., Minnesota Point, examination and survey of	247			2306	
Superior Bay, Wis., injury to channels in					3493
Superior Bay and St. Louis Bay, harbor at, Wis., improvement of	243			2291	
Superior, Lake, Minnesota Point, Superior, Wis., at west end of, examination and survey of	247			2306	
Superior, Lake, survey of reef near mouth of Gooseberry River, Minn	350				3583
Supervision of the Harbor of New York	330				3077
Survey of the Northern and Northwestern Lakes	350				3583
Survey of reef near mouth of Gooseberry River, Lake Superior, Minn	350				3583
Survey of road from Aqueduct Bridge, D. C., to Mount Vernon, Va	350				3563
Survey of San Francisco Harbor, San Pablo and Suisun bays, Straits of Carquinez, and mouths of San Joaquin and Sacramento rivers	311				2890
Surveys and reconnaissances, estimate for	355				
Surveys, examinations and	13				
Surveys for reservoirs at sources of Mississippi, St. Croix, Chippewa, and Wisconsin rivers	215			2098	
Susquehanna River, above and below Havre de Grace, Md., improvement of	98	934			
Suwanee River, Fla., improvement of	155		1611		
T.					
Tallahatchee River, Miss., improvement of	192			1897	
Tallapoosa River, Ala., improvement of	165		1649		
Tampa Bay, Fla., improvement of	153		1604		
Tar and Pamlico rivers, N. C., improvement of	122		1112		
Taunton River, Mass., improvement of	42	563			
Taunton River at Somerset, Mass., bridge obstructing	340				
Tchefuncte River and Bogue Falia, La., improvement of	175		1737		
Tchula Lake, Miss., improvement of	192			1896	
Telegraph to connect the Capitol with Departments and Government Printing Office, Washington, D. C					3549
Ten Islands to rapids at Wetumka, Coosa River from, examination and survey of	167		1658		
Ten Miles Rapids, Columbia River, Oregon and Wash., overcoming obstructions at					3039
Tennessee Midland Railway Company, bridge of, over Tennessee River	336				
Tennessee River, bridges obstructing	339				
Tennessee River, improvement of	216			2111	
Tennessee River above Chattanooga, Tenn., improvement of	216			2112	
Tennessee River below Chattanooga, Tenn., improvement of	217			2114	
Tennessee River at Florence, Ala., bridge over	339				

Subject.	Page. Part I.	Part II.	Part III.	Part IV.
Tennessee River at Johnsonville, Tenn., bridge over	340			
Tennessee River, at Perryville, between Decatur and Perry counties, Tenn., bridge over	336			
Tensas River and Bayou Macon, La., improvement of	190		1888	
Tensas River, near Daniel's Ferry, La., bridge over	337			
Terre Bonne Bayou, La., improvement of	178	1745		
Texas and Vienna, Sipsey River, Ala., between, examination and survey of	175	1722		
Thames River, Conn., improvement of	51 600			
The Board of Engineers	6			
Three Mile Rapids, Columbia River, Oregon and Wash., overcoming obstructions at				3028
Thunder Bay Harbor, Mich., improvement of	278		2722	
Tickfaw River and its tributaries, La., improvement of	176	1739		
Ticonderoga River, N. Y., improvement of	309		2882	
Tillamook Bay and Bar, Oregon, improvement of	321			2979
Toledo Harbor, Ohio, old channel, improvement of	290		2755	
Toledo Harbor, Ohio, straight channel, improvement of	290		2755	
Tombigbee River, Miss. and Ala., from Fulton to Vienna, improvement of	170	1701		
Tombigbee River, Ala., below Vienna, examination and survey of	175	1716		
Tombigbee River, Ala., below Vienna, improvement of	171	1703		
Tombigbee River, from Vienna, Ala., to Cotton Gin, Miss., examination and survey of	175	1716		
Tombigbee River at Vienna, and Texas, Sipsey River, Ala., between, examination and survey of	175	1722		
Tombigbee River, Miss., from Walker's Bridge to Fulton, improvement of	170	1700		
Tonawanda (barge), removal of wreck of	92 905			
Tonawanda Harbor and Niagara River, N. Y., improvement of	299		2839	
Torpedo-casemates	5			
Torpedo experiments	6			
Torpedo service, instruction of Engineer troops in	6			
Torpedoes	6			
Totusky River, Va., improvement of	116	1071		
Tradewater River, Ky., improvement of	236		2253	
Trail Creek at Michigan City, Ind., bridge over	338			
Trent River, N. C., improvement of	124	1119		
Trinity River, Tex., improvement of	184	1802		
Troy and New Baltimore, N. Y., Hudson River between, establishment of harbor lines in	332 766			
Tunneling Detroit River at Detroit, Mich	13			3462
Tuscaloosa and Daniels Creek, Black Warrior River, Ala., between, improvement of	168	1696		
Tuscaloosa and Demopolis, Warrior River, Ala., between, examination and survey of	175	1716		
Two Brothers (schooner), removal of wreck of	101 942			
Two Rivers Harbor, Wis., improvement of	252		2342	
U.				
Umpqua River, Oregon, improvement of	319			2965
Umpqua River, Oregon, between Scottsburgh and the mouth, examination and survey of	324			3005
Union River and Union River Bay, Me., examination and survey of	26 458			
Upper Columbia River, Wash., between Wallula and British line, examination and survey of	329			3065
Upper Columbia and Snake rivers, Oregon and Wash., improvement of	322			2981
Upper Mississippi River, operation of snag-boats and dredge-boats on	207		2021	
Urbana Creek, Rappahannock River, Va., improvement of	115	1070		
V.				
Vermillion Harbor, Ohio, improvement of	293		2774	
Vienna, Ala., Tombigbee River below, examination and survey of	175	1716		
Vienna, Ala., Tombigbee River below, improvement of	171	1703		
Vienna, Ala., and Cotton Gin, Miss., Tombigbee River between, examination and survey of	175	1716		
Vienna and Fulton, Tombigbee River, Miss. and Ala., between, improvement of	170	1701		
Vienna and Texas, Sipsey River, Ala., between, examination and survey of	175	1722		
Vincennes, Ind., Wabash River above, improvement of	231		2232	
Vincennes, Ind., Wabash River below, improvement of	231		2225	
Vineyard Haven Harbor, Mass., improvement of	39 556			
Volusia Bar, Fla., improvement of	149	1564		

Subject.	Page. Part I.		Part II.	Part III.	Part IV.
W.					
Wabash Railway Company, bridge of, over Mississippi River	338				
Wabash River above Vincennes, Ind., improvement of	231			2232	
Wabash River below Vincennes, Ind., improvement of	231			2229	
Waccamaw River, N. C. and S. C., improvement of	140		1229		
Walker's Bridge and Fulton, Tombigbee River, Miss., between, improvement of	170		1700		
Wallace (barge), removal of wreck of	92	905			
Wallula, Wash., and British line, Columbia River between, examination and survey of	329				3065
Wando and Owendaw rivers and other waters connecting Bull's Bay and Charleston Harbor, S. C., examination and survey of	141		1239		
Wappinger's Creek, from Wappinger's Falls to its mouth, N. Y., examination and survey of	74	758			
Wappinger's Falls, Wappinger's Creek from, to its mouth, N. Y., examination and survey of	74	758			
Wappoo Cut, S. C., improvement of	140		1227		
Ward's Bank, mouth of St. John's River, Fla., wreck at, removal of	156		1614		
Wareham Harbor, Mass., improvement of	40	558			
Warren River, R. I., improvement of	43	565			
Warrior River, Ala., improvement of	169		1698		
Warrior River, Ala., from Tuscaloosa to Demopolis, examination and survey of	175		1716		
Washington Aqueduct	345				3501
Washington, D. C., Aqueduct Bridge, to Mount Vernon, Va., survey of road from	350				3563
Washington, D. C., defenses below	4				
Washington, D. C., increasing water supply of	348				3531
Washington, D. C., Potomac River at, improvement of	108		1037		
Washington, D. C., public buildings and grounds, improvement and maintenance of	349				3535
Washington, D. C., report on bridge over Potomac River at			1045		
Washington, D. C., telegraph to connect the Capitol with Departments and Government Printing Office					3549
Washington, D. C., Washington Aqueduc	345				3501
Washington, D. C., Washington Monument, care and maintenance of	349				3536
Washington County, Ohio, bridges of, over Muskingum River	341				
Washington Monument, Washington, D. C., care and maintenance of	349				3536
Wateree River, S. C., improvement of	139		1222		
Waterford, Ohio, bridge over Muskingum River at	341				
Water-gauges on Mississippi River and its principal tributaries	194			1908	
Water-level observations for Lake Erie	351				3583
Water-routes connecting Bull's Bay and Charleston Harbor, S. C., examination and survey of	141		1239		
Water supply, District of Columbia	346				3522
Water supply of Washington, D. C., increasing	348				3531
Waters River of Essex Branch, Mass., examination and survey of	38	517			
Water-way between Beaufort Harbor and New River, N. C., improvement of	127		1138		
Water-way from Chincoteague Bay, Va., to Delaware Bay, near Lewes, Del., improvement of	97	930			
Water-way between Coaster's Harbor Island and Rhode Island, examination and survey of	51	590			
Water-way from Lake Michigan to Illinois River at La Salle, Ill., survey of				2419	
Water-way between New Berne and Beaufort, N. C., improvement of	125		1127		
Waukegan Harbor, Ill., improvement of	256			2361	
Well, artesian, at Fort Monroe, Va	5				
Wellfleet Harbor, Mass., improvement of	36	512			
West Liberty and Farmer's, Licking River, Ky., between, improvement of	238			2273	
West Shore Railroad, bridge of, over Moodna or Murderer's Creek, N. Y	342				
West Virginia and Ironton Railroad Company, bridge of, over Ohio River	337				
Wetumka Rapids, Coosa River from, to improvements above Ten Islands, Ala., examination and survey of	167		1658		
Weymouth (Fore) River, Mass., examination and survey of	38	521			
Wharf at Fort Monroe, Va	9	385			
Wheeling Bridge Company, bridge of, over Ohio River	336				
Wheeling, W. Va., bridge over Ohio River at	336				
White River, Ark., improvement of	199			1942	
White River, Ind., bridges obstructing	341				

Subject.	Page. Part I.		Part II.	Part III.	Part IV.
White River, Ind., improvement of	232			2234	
White River, near Hazleton, Ind., bridge over	341				
White River, at Rogers, Ind., bridge over	341				
White River Harbor, Mich., improvement of	268			2634	
Wicomico River, Md., examination and survey of	102	947			
Willamette River, above Portland, Oregon, improvement of	328				3061
Willamette, Lower, and Columbia rivers, below Portland, Oregon, improvement of	327				3058
Willets Point, N. Y., Post of	10	389			
Willets Point, N. Y., Post of, Engineer Depot	11	398			
Willets Point, N. Y., Post of, Engineer School of Application	10	392			
Wilmington, N. C., Cape Fear River, above, improvement of	129		1148		
Wilmington, N. C., Cape Fear River, at and below, improvement of	130		1152		
Wilmington Harbor, Cal., improvement of	112				2900
Wilmington Harbor, Del., improvement of	93	917			
Wilson Harbor, N. Y., improvement of	300			2842	
Wilson River, Va., New River from mouth of, to mouth of Greenbrier River, W. Va., improvement of	235			2249	
Winnebago Lake, Wis., harbor at mouth of Fond du Lac River, examination and survey of	259			2389	
Winthrop Harbor, Mass., improvement of	32	496			
Winyaw Bay, S. C., improvement of	132		1169		
Wisconsin River, Wis., surveys for reservoirs at sources of	215			2098	
Wisconsin and Fox rivers, Wis., improvement of	257			2365	
Wisconsin and Fox rivers, Wis., use of water power on					3494
Withlacoochee River, Fla., improvement of	154		1606		
W. M. B. Adamson (canal-boat), removal of wreck of	121		1085		
Wood's Holl, Little Harbor, Mass., wreck at, removal of	50	584			
Worthville, Ky., bridge over Kentucky River at	342				
Wreck in Ashtabula Harbor, Ohio, removal of	296			2787	
Wreck in Cambridge Harbor, Md., removal of	101	942			
Wreck at Charleston Bar, S. C., removal of	141		1233		
Wreck in Chesapeake Bay, in channel between Cape Henry and Hampton Roads, Va., removal of	108	1029			
Wreck in Chesapeake Bay, between Hooper's and Kedge's straits, removal of	942				
Wreck in Chesapeake Bay, near Sharp's Island, removal of	101	942			
Wreck in Choptank River, Md., removal of	101	942			
Wreck at Cuttyhunk Pond, Cuttyhunk Island, Mass., removal of	50	584			
Wreck in Great Wicomico River, at mouth of Cockle's Creek, Va., removal of	121		1085		
Wreck near Handkerchief light-ship, removal of	50	585			
Wreck in Hempstead Harbor, N. Y., removal of	62	667			
Wreck in Little Harbor, Woods Holl, Mass., removal of	50	584			
Wreck in Newburyport Harbor, Mass., removal of	37	516			
Wreck in Pamunky River, at Skidmore's Bar, Va., removal of	121		1084		
Wreck near Pollock Rip light-ship, removal of	50	583			
Wreck in Provincetown Harbor, Mass., removal of	37	516			
Wreck in St. John's River, Fla., removal of	156		1614		
Wreck at Ward's Bank, mouth of St. John's River, Fla., removal of	156		1614		
Wrecks in Delaware Bay and River, removal of	92	904			
Wrecks and snags, removing, from Mississippi River	203			1969	
Wrecks obstructing or endangering navigation, removal of	13				
Y.					
Yadkin River, N. C., improvement of	131		1161		
Yaquina Bay, Oregon, improvement of	320				2967
Yazoo River, Miss., improvement of	191			1892	
Yellow Banks, Chippewa River, Wis., improvement of	212			2084	
Yellowstone National Park, construction and improvement of roads and bridges in	352				2591 3591
Yellowstone River, Mont. and Dak., improvement of	215			2098	
Yerba Buena Island, Cal., torpedo station at	6				
York Harbor, Me., improvement of	23	450			
York River, Va., improvement of	118		1076		
Young's River, and its tributary, Klaskuine River, Oregon, examination and survey of	324				2989
Z.					
Zanesville, Ohio, bridges over Muskingum River at	336	341			